(12)

AD

TECHNICAL REPORT

NATICK/TR-81/011

ADA097819

PLATE WASTE IN SCHOOL FEEDING PROGRAMS: INDIVIDUAL AND AGGREGATE MEASURES

AN INTERAGENCY PROJECT

FOR

OFFICE OF POLICY, PLANNING AND EVALUATION

FOOD AND NUTRITION SERVICE

U.S. DEPARTMENT OF AGRICULTURE (USDA)

Elizabeth M. Comstock

Lawrence E. Symington

Hilary E. Chmielinski

Judith S. McGuire

December 1979

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

UNITED STATES ARMY

RESEARCH and DEVELOPMENT LABORATORIES

NATICK, MASSACHUSETTS 01760

Food Sciences Laboratory

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: 14 NATICK/TR-81/011

2. GOVT ACCESSION NO.: AD-A097 829

3. RECIPIENT'S CATALOG NUMBER:

4. TITLE (and Subtitle): 6) PLATE WASTE IN SCHOOL FEEDING PROGRAMS: INDIVIDUAL AND AGGREGATE MEASURES.

5. TYPE OF REPORT & PERIOD COVERED: 9) Final rept.,

6. PERFORMING ORG. REPORT NUMBER:

7. AUTHOR(s): 10 Elizabeth M. Comstock, Lawrence E. Symington, Hilary E. Chmielinski[redacted] Judith S. McGuire

8. CONTRACT OR GRANT NUMBER(s):

9. PERFORMING ORGANIZATION NAME AND ADDRESS: Food Sciences Laboratory, US Army Natick Research & Development Command, Natick, MA 01760

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 6.2 USDA Reimbursable Agreement #FNS 58-3198-9-30

11. CONTROLLING OFFICE NAME AND ADDRESS: US Army Natick Research & Development Command, ATTN: DRDNA-YBH, Natick, MA 01760 (11)

12. REPORT DATE: Dec[redacted]979

13. NUMBER OF PAGES: 101 12) 97

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):

15. SECURITY CLASS. (of this report): Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

AGGREGATE SELECTIVE PLATE WASTE	FOOD WASTE	SCHOOL BREAKFAST PROGRAM
FOOD	INDIVIDUAL PLATE WASTE	SCHOOL FEEDING
FOOD CONSUMPTION	NATIONAL SCHOOL LUNCH PROGRAM	WASTE
FOOD HABITS	PLATE WASTE	WASTE MEASUREMENT METHODS

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Methods of measuring plate waste were reviewed and evaluated in order to select, pretest, and develop the method best suited to an economic analysis of waste in school feeding programs. Aggregate selective plate waste was the method chosen because it appeared to be fast, accurate, and easy to learn. Six other methods considered all had serious drawbacks. Aggregate selective plate waste measurement involves collecting trays from all, or a sample, of the students in a lunchroom and separately scraping the waste from each food item. Waste is accumulated across students before being weighed at the end of the meal. During development and pretesting, →

DD FORM 1473, 1 JAN 73 — EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. Abstract (cont'd)

It was determined that aggregate selective plate waste can be collected from approximately 300 students during typical lunchroom operation. In lunchrooms serving more than 300 students, a sample of 300 students was found to provide acceptably accurate measures of waste for most food items. Recommendations were developed for staff, equipment, sampling procedures, and scraping procedures.

EXECUTIVE SUMMARY

The objectives of the research presented in this report were to review and evaluate methods of measuring food waste in institutional feeding systems, to select the method best suited to a national economic study of waste in the National School Lunch Program and the School Breakfast Program, and to pretest and modify the method to make it as accurate and efficient as possible.

The method was chosen to be appropriate for data collected on an institutional level, and flexible enough for use with different serving systems, menu items, school sizes, and age groups. In addition, the method should be reliable and valid, and should minimize cost and time requirements. Of the seven methods reviewed in Chapter 2, four were found to be clearly unsuitable. Aggregate nonselective plate waste does not provide enough information about specific food items wasted. Garbage analysis involves allowing tray waste to become mixed in the garbage containers, necessitating the time-consuming procedure of separating the foods again. Food preference questionnaires were found to be of questionable reliability and validity as measures of waste. Self-estimation is subject to large student error and bias.

Three methods – individual plate waste, aggregate selective plate waste, and visual estimation – were all considered applicable within the range of serving systems, kinds of menus, waste disposal systems, and school sizes described in Chapter 3. Aggregate selective plate waste was the method chosen, because it appeared to provide the necessary information on amount of waste, and was fast, accurate, and easy to learn. The other methods had serious drawbacks. Individual plate waste, while it would provide more detailed information, was judged to be too time-consuming. Comparisons of time, included in Chapters 4 and 5, show individual plate waste to require between two and three times longer than aggregate selective plate waste. Visual estimation was judged to be inadequately tested as a method, to be of questionable accuracy, to require more time for training researchers, and to require no less time at each school than the other methods.

Aggregate selective plate waste measurement involves collecting trays from all, or a sample, of the students in a lunchroom and separately scraping the waste from each food item. Waste is accumulated across students before being weighed at the end of the meal. Development and pretesting of this method centered on three methodological issues: First, how many trays need to be scraped to obtain an acceptably accurate estimate of total waste for each food item? Second, how much time is required for aggregate selective plate waste measurement? Third, what procedures are the most efficient?

Although the best measure of aggregate selective plate waste will be obtained by scraping all trays in a lunchroom, this procedure is not always practical, particularly in large schools and when time is limited. When not all trays can be scraped, the number of trays required in the sample depends on two major factors: the first factor is the degree of accuracy desired; larger samples yield more accurate estimates. For purposes of this, the accuracy criterion was a relative standard error of the mean (or total) equal to 0.10 or less. The second influence on required sample size is the variability of the waste of a food item from tray to tray. The greater the variability, the more trays must be sampled to reach the accuracy criterion. Since

no measures of the variability of plate waste were found in the literature, variability was measured for a total of 62 food items in two summer feeding programs (see Chapter 4) and two regular school lunch programs (see Chapter 5). The type of lunch service ranged from no-choice, prepackaged lunches to self-serve lunches with numerous menu choices. In general, variability of waste was very high, and, therefore, desirable sample sizes were large for most food items.

Based on the variability data, it is recommended that, in lunchrooms with fewer than 300 meals served, all trays be scraped for aggregate selective plate waste. In lunchrooms with more than 300 meals served, it is recommended that trays be sampled to obtain a total of approximately 300 trays. A sample size of 300 allows the accuracy criterion to be met in most situations for most food items. For example, if a population size of 500 is assumed, sampling 300 trays allows the accuracy criterion to be met for 38 of 62 food items. Of the remaining food items, relative standard errors never exceeded 0.28 and were more typically closer to the desired 0.10. Errors in estimating waste will tend to be largest for foods wasted the least, and thus, will contribute least to the cost of the waste.

Measurements of the time required for aggregate selective plate waste indicate that 300 trays can be scraped in a reasonable amount of time. A team of two to four researchers can scrape about 50 trays per person per hour. Weighing at the end of the meal requires another ten to fifteen minutes. Therefore, aggregate selective plate waste can easily be collected from 300 students during the one and a half to two hours of typical lunchroom operation. Another 30 to 45 minutes for setup and cleanup activities brings the total time in a lunchroom to between two and three hours. By comparison, collection of individual plate waste requires between two and three times longer.

The basic procedures recommended for collecting aggregate selective plate waste are described in Chapter 6. Suggested staff, equipment, sampling procedures, and scraping procedures are all straightforward and fairly simple to employ. The following additional recommendations are made. Since the biggest problem logistically is the buildup of incoming trays, it is recommended that ample table or rack space be available, and that one researcher devote full attention to receiving and sampling incoming trays. Counting of trays scraped should not be done until these trays are returned to the dishroom after scraping is complete. Waste from milk and juice are consistently difficult to estimate accurately; therefore, researchers should consider collecting all liquid waste, even when only a sample of waste from other foods is collected. Finally, since every lunchroom operates differently, it is recommended that researchers visit the lunchroom to observe prior to the day on which data are to be collected.

PREFACE

The Behavioral Sciences Division (BSD) of the Food Sciences Laboratory (FSL), United States Army Natick Research and Development Command (NARADCOM) was requested to evaluate methods for measuring food consumption and waste in institutional feeding systems by the Office of Policy, Planning, and Evaluation (OPPE), Food and Nutrition Service (FNS), United States Department of Agriculture (USDA). Funding for this effort was provided under Agreement Number FNS 58–3198–9–30.

The authors would like to acknowledge the contributions made toward this effort by individuals both outside and within BSD. The two individuals from OPPE, FNS, USDA who monitored this effort, Dr. Sandra Huffman and Dr. Steven Gale, were extremely helpful to us. Our initial observations of schools were greatly facilitated by Mr. John Stalker and Miss Louise Watts of the Bureau of Nutrition Education and School Food Services, Massachusetts Department of Education, and by Dr. Lloyd Littlefield, Food and Nutrition Service, State of New Hampshire. There was a high level of cooperation extended by food service personnel in virtually every school visited. Particular appreciation is extended to the following individuals: Kathryn Brophy, Kenneth Gebo, Maura Hennigan, Mary McGlaughlin, Elizabeth Murray, and Herbert Wallace.

Within BSD, several individuals contributed to the overall effort. Dr. Harry Jacobs, Chief of the Division, was instrumental in the initial contact with USDA and provided the primary shaping of the project scope. Gina Cosimini, Nancy Curran, and Joseph Hunn were integral members of the waste data collection team. Dr. Herbert Meiselman also assisted in data collection, and he and Dr. William Wilkinson provided numerous thoughtful comments in their reviews of the manuscript. Lorenz Digman provided statistical expertise for the analysis of probable sampling error. We also express our appreciation to Charlene Slamin and Veronica O'Brien for their patience and expertise in producing the various drafts and final manuscript.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (cont'd)

PLATE WASTE IN SCHOOL FEEDING PROGRAMS: INDIVIDUAL AND AGGREGATE MEASURES

CHAPTER 1

INTRODUCTION

The Behavioral Sciences Division (BSD) of the Food Sciences Laboratory (FSL), United States Army Natick Research and Development Command (NARADCOM) was requested by the Office of Policy, Planning, and Evaluation (OPPE), Food and Nutrition Service (FNS), United States Department of Agriculture (USDA) to evaluate methods for measuring food consumption and waste in institutional feeding systems. Specifically, the objectives of this effort were to evaluate currently available direct and indirect methods of measuring food waste applicable to food items in institutional feeding systems; to select the best available food waste measurement method(s) applicable to a large scale food program evaluation; and to pretest and modify the method(s) to apply to a large scale economic study of the national school lunch and breakfast programs. Two additional objectives of this work effort – the generation of a literature review concerning food consumption measures, and the design of a protocol for a methodological study to evaluate and modify methods for further use in evaluating the nutritional impact of school lunch and breakfast programs on the consumer – are being addressed outside of this report.

The report is organized in a rough approximation to the time sequence actually followed in the research effort. The initial task was an extensive review of the literature dealing with plate waste measurement; that review is presented in the next section of the report. A concurrent undertaking involved preliminary observations of various school lunch programs in order to obtain a better understanding of such operations, particularly with respect to potential waste measurement problems. These observations are detailed in Chapter 3.

The next section of the report addresses the rationale for the proposed method, aggregate selective plate waste. This rationale is followed by discussion of the pretests of the aggregate selective plate waste method. The report concludes with recommended procedures for use of the proposed method.

CHAPTER 2

REVIEW OF LITERATURE ON PLATE WASTE MEASUREMENT

As the initial task of the effort to select the best available measure of food waste applicable to a large scale economic study of the National School Lunch Program and the School Breakfast Program, an extensive review of the literature was undertaken. The reference list and the bibliography contain a complete list of sources reviewed in the areas of food waste and food consumption in children, with particular application to the school lunch program. The discussion presented here focuses on the methodological considerations involved in selecting among measures of plate waste. Food consumption measures will be reviewed elsewhere. For data on specific factors which influence amounts of waste in the school lunch program, see Altschul's (1976)[1] review.

Plate waste measures can be divided into two broad categories – direct measures and indirect measures. Direct measures include weighing the waste of separate food items for individual students or groups of students, weighing total unseparated waste, and separating and weighing waste from garbage containers. Indirect measures include measuring food preference or acceptability, visually estimating amounts of each menu item wasted, and asking students to report the amounts they wasted. In the review which follows, each of these measures will be described and evaluated. The description will include procedures commonly employed, situations in which the measures are commonly applied, and some representative results.

Evaluation of plate waste measures will consider reliability and validity, range of applicability, and cost. Shortcomings of studies employing these methods will also be discussed; these include methods of sampling and other design problems. It is important to note that most studies of plate waste are designed to characterize relative amounts of waste that occur for different menu items or to test hypotheses about factors which influence amounts of plate waste. They were not designed to evaluate the measures. Therefore, data on which to base an evaluation are often incomplete.

DIRECT MEASURES OF WASTE

Individual plate waste

Individual plate waste is measured by weighing the leftovers from the separate food items on the trays of individual students. Initial serving size is also measured when waste is to be expressed as a proportion of food served or when amount of food consumed is of interest. Often only a sample of trays is weighed and used to estimate average waste per student.

Individual plate waste is the criterion against which other estimates and indirect measures of waste have traditionally been compared. It might be noted here that many investigators have also attempted to use individual plate waste to calculate individual consumption (e.g.,

[1] Altschul, A.M. Studies in school lunch waste – A literature review and evaluation. USDA/FNS Contract 557–FNS--76, 1976.

Harper & Jansen, 1973;[2] Jansen & Harper, 1978;[3] Head & Weeks, 1977(b)[4]). This procedure is not necessarily accurate, especially where there is much trading and spillage among students, and where there are large variations in serving size.

A common design for individual plate waste studies involves indicating the student's food choices on a card as he goes through the cashier's station, leaving the lower portion of the card on the tray, and recording the weight of the leftovers on the back of the card as the waste is being disposed of (e.g., Jansen & Harper, 1978;[5] Meredith, et al., 1951;[6] Head & Weeks, 1975[7]). If the mean serving size of each food is desired, it is usually estimated from the mean of four or five servings.

Numerous factors have been found to influence the amount of individual plate waste in school lunches. For example, younger students were reported to waste more than older ones (Augustine, et al; 1950;[8] Hunt, et al; 1958;[9] Mirone & Harvey, 1954;[10] Patton, et al; 1958[11])

[2] Harper, J.M. and G.R. Jansen. Phase II Report; Comparison of Type A and NSM menus in the National School Lunch Program. USDA/FNS Contract 12–35–600–85, 1973.

[3] Jansen, G.R. and J.M. Harper. Consumption and plate waste of menu items served in the National School Lunch Program. **Journal of the American Dietetic Association, 1978, 73,** 395–400.

[4] Head, M.K. and R.J. Weeks. Conventional vs. formulated foods in school lunches. II. Cost of food served, eaten and wasted. **Journal of the American Dietetic Association,** 1977b, **71,** 629–632.

[5] See footnote 3.

[6] Meredith, A., A. Matthews, M. Zickefoose, E. Weagley, M. Wayave and E.G. Brown. How well do school children recall what they have eaten? **Journal of the American Dietetic Association,** 1951, **27,** 749–751.

[7] Head, M.K. and R.J. Weeks. Major nutrients in the Type A lunch. II. Amounts consumed by students. **Journal of the American Dietetic Association,** 1975, **67,** 356–360.

[8] Augustine, G., M.McKinley, S.L. Laughlin, E.L. James and E. Eppright. Nutritional adequacy, cost and acceptability of lunches in an Iowa school lunch program. **Journal of the American Dietetic Association,** 1950, **26,** 654–662.

[9] Hunt, F.E., M.B. Patton and A.F. Carver. Plate waste in a school lunch III. Vegetable acceptance study. **Journal of the American Dietetic Association,** 1958, **34,** 810–813.

[10] Mirone, L. and L.G. Harvey. A new menu pattern is tested. **Journal of the American Dietetic Association,** 1954, **30,** 757–761.

[11] Patton, M.B., A.F. Carver and F.E. Hunt. Plate waste in a school lunch. II. Sources of waste. **Journal of the American Dietetic Association,** 1958, **34,** 733–737.

and girls to waste more than boys (USDA/FNS, 1978(a);[12] USDA/FNS, 1978(b)[13]). Family style service in schools was reported to produce less waste than cafeteria style (Brine, 1956),[14] but bulk serving apparently generated less waste than preportioned lunches (USDA/FNS, 1976).[15] **A la carte** choice produced as much waste as the Type A lunch in one study (Sando and Patton, 1956),[16] but free choice generated less waste than "offered vs. served" or preplated lunches in another (USDA/FNS, 1978(b)).[17]

Vegetable acceptance is another area in which individual plate waste has been measured (Ireton & Guthrie, 1972;[18] Hunt, et al; 1958;[19] Patton, et al; 1958;[20] Sando & Patton, 1951[21]). These studies have focused specifically on ways to decrease waste from vegetables which generally is the food group most wasted in school lunch programs.

[12] USDA/FNS. Food consumption in the National School Lunch Program. 1978a.

[13] USDA/FNS. Pilot study to compare Type A lunches with alternative subsidized lunches among high school students. Contract No. 12–35–600–351, 1978b.

[14] Brine, C.L. and E.B. Tate. Effect of food losses on nutritive content of diets in four institutions. **Journal of the American Dietetic Association**, 1956, **32**, 19–23.

[15] USDA/FNS. Pilot study to assess, audit, and evaluate food delivery systems used in school food service. Contract No. 12–35–600–183, 1976.

[16] Sando, L.G. and M.B. Patton. Lunch programs in Ohio Public Schools. **Journal of the American Dietetic Association**, 1951, **27**, 285–288.

[17] See footnote 13.

[18] Ireton, C.L. and H.A. Guthrie. Modification of vegetable-eating behavior in preschool children. **Journal of Nutrition Education**, 1972, **4**, 100–103.

[19] See footnote 9.

[20] See footnote 11.

[21] See footnote 16.

Individual plate waste has not been specifically tested for validity, probably because there appears to be no more accurate method. Since food separation and individual weighings are time-consuming, a sample of trays is often used to estimate both initial serving size and the amount of waste. More trays are typically sampled to estimate waste than to estimate serving size, but no data on the variability of either waste or serving size were found in the literature. Therefore, it is not possible to know the degree of accuracy obtained with the sample sizes used in individual plate waste studies. Preliminary weighings done by the NARADCOM research team showed very large variability in both serving size and waste, suggesting that estimates based on small sample sizes should be treated with caution.

Sampling procedures should also ensure that the trays weighed are representative of the populations to which inferences are to be drawn. In particular, the findings on factors which influence plate waste suggest that sampling within schools should be representative of age and sex ratios and menus of differing popularity. Among schools, sampling must take into account various serving and preparation methods.

A second difficulty with the individual plate waste measure is that it requires a fairly major intervention in cafeteria procedures. Students given tray cards are usually aware that their plate waste will be measured, and so may alter their eating behavior.

Finally, the individual plate waste measure is time-consuming (and, therefore, costly) relative to other methods. For this reason, individual plate waste has been eliminated by USDA from the methodological options for the future studies toward which this review is directed.

Aggregate selective plate waste

Waste separated by food item and accumulated from several people before weighing is called "aggregate selective plate waste". Aggregate waste is easier and quicker to weigh than the leftovers from individual plates, but it cannot provide data on variability in waste or consumption within or between individuals. Usually a fixed proportion of the students' trays is sampled and assumed to provide an unbiased estimate of group plate waste. Mean aggregate plate waste will equal mean individual plate waste, as long as the samples are representative.

Aggregate selective plate waste methods have most frequently been applied when students have no choice among the menu items being measured. For example, Robinson (1978)[22] collected multiple samples of milk cartons (20 per sample) returned during lunch periods of schools with and without the special milk program and found that the program did not contribute to milk waste at lunch. However, in schools where more children were eligible for free milk, higher milk waste was noted.

[22] Robinson, J.S. Special milk program evaluation and National School Lunch Program survey. USDA/FNS: 1978, 52–57.

Bell and Lamb (1973)[23] measured milk and vegetable waste to test the effect of nutrition education on consumption of those items. The plate waste of the nutrition education class was weighed as a whole, both before and after a specific education program. Milk consumption did not change relative to pre-nutrition education levels, but vegetable consumption increased. There are at least two methodological problems with this study. First, milk waste may not have increased because it was already a highly consumed food item. Second, since students weighed their own waste, they may have been biased in their eating when measurements were taken.

Head and Weeks (1977(b))[24] used aggregate selective plate waste to determine the effect of formulated foods on consumption of elementary school students. Some menus used formulated foods in which nutrient-dense components were substituted for, or added to, traditional foods. Aggregating waste of 70 students in each age group (grades 1 – 3 and 4 – 6) in five schools over two test periods of 20 menus each, Head and Weeks found that serving formulated foods increased consumption as a proportion of serving size. They also found that rural children (two schools) consistently consumed more than urban children (two schools).

Martin (1971)[25] used aggregate waste to test whether elementary and junior high school students preferred hot lunches to cold lunches of equal preference ratings. The proportion of the serving that was wasted (not the absolute amount of waste) was higher in the cold lunch than the hot lunch. Elementary school students consistently wasted more than junior high school students. The preference-matching methodology is of questionable value in comparing plate waste since other factors enter into consumption (e.g., method of preparation, environmental temperature, amount of inedible waste).

When not all students receive the same foods, sampling procedures take on a particularly important role. More trays must be weighed to obtain a given degree of accuracy in the mean plate waste for each food item. One study (Head and Weeks, 1975)[26] handled a situation with many food choices by distributing food acceptability cards as the children selected their lunches, asking them to evaluate those items consumed and to return the form with the tray at the time of waste disposal. Assuming that the students did not evaluate foods they did not eat (perhaps a naive assumption and not validated at any rate), the investigators used the number of times a food item was evaluated as the number of servings from which aggregate waste had been collected. The results were expressed in terms of waste of specific food items per individual served.

[23] Bell, C.G. and M.W. Lamb. Nutrition education and dietary behavior of fifth graders. **Journal of Nutrition Education**, 1973, **5**, 196–199.

[24] See footnote 4.

[25] Martin, K.M. Nutritional adequacy, preference, acceptability, and food production aspects of hot and cold school lunches. Ph.D. Thesis, Pennsylvania State University, 1971.

[26] See footnote 7.

The validity of aggregate selective plate waste measurement depends on the same factors of size and representativeness of samples which were discussed for individual plate waste. An additional caution occurs with aggregated waste, however. When individual plate waste data are collected, variability in amount of individual waste for each food item can be calculated; from these data an estimate of the accuracy of the mean can also be calculated. When plate waste is aggregated, no data on individual variability are obtained, and therefore the accuracy of the estimated mean waste is not known.

Aggregate selective plate waste measurement should take less time than individual plate waste measurement; however, the amount of time saved is not known, since no data were found on the relative requirements of the two methods. Also, aggregate selective plate waste measurement should require little disruption of normal cafeteria routines, especially when it is not necessary to know what each student was served.

Aggregate nonselective plate waste

Aggregate nonselective plate waste is overall edible waste left over on the plate, not separated by food item or individual. In some applications, milk is collected separately from other food items. Nonselective waste measurement provides a gross estimate of food losses but does not yield quantitative information on specific food items consumed or wasted.

Nonselective plate waste was used successfully by Carver and Patton (1958)[27] to monitor general food acceptance in school lunches. The results agreed with findings mentioned above that younger students wasted more than older students. Similarly, Hageman (1945 (a) and (b))[28,29] used the method with hospital patients to determine whether menu choice affected gross waste of food. She found that clinic patients without any choice ate less than private patients (always with choice) who, in turn, ate less than clinic patients who were given a choice of menus.

It is possible to measure the nutrient composition of nonselective plate waste by homogenizing and chemically analyzing the food waste. For example, Guthrie (1977)[30] used nutrient analysis of gross waste (with milk waste separated) to study the effect of the chocolate milk option on food waste and consumption. Food waste increased and milk waste decreased

[27] Carver, A.F. and M.B. Patton. Plate waste in a school lunch, I. Overall waste. **Journal of the American Dietetic Association**, 1958, **34**, 615–618.

[28] Hageman, M.I. A study of plate waste as a directive measure in food conservation: Part I. **Journal of the American Dietetic Association**, 1945, (a) **21**, 608–610.

[29] Hageman, M.I. A study of plate waste as a directive measure in food conservation: Part II. **Journal of the American Dietetic Association**, 1945, (b) **21**, 685–689.

[30] Guthrie, H.A. Effect of a flavored milk option in a school lunch program. **Journal of the American Dietetic Association**, 1977, **71**, 25–30.

when chocolate milk was offered to the students. On the basis of food preparation costs, she concluded that since milk waste cost less than food waste, chocolate milk was not a desirable option for the lunch program.

Aggregate nonselective plate waste is not useful for the purposes of an economic study of waste. The biggest difficulty is that it does not give the essential information on actual foods which were wasted. Even with nutrient analysis, a time-consuming and expensive procedure, there is no tested method for inferring foods from which those nutrients came or the cost of the waste.

Garbage Analysis

Another direct estimate of food waste is garbage separation and analysis. Rathje and Harrison (Rathje and Harrison, 1978;[31] Harrison, et al., 1975[32]) were the pioneers in the field and have produced the principal studies to date. They took garbage containers from the street, manually separated food from trash, and estimated food inputs from labels on packages. Consumption was calculated as food input minus observed waste.

The major advantage of this method is that it is unobtrusive – none of the subjects knew his garbage was being analyzed. It is time-consuming, however, and inaccurate. Researchers must depend on correction factors for food that is used without its evidence reaching the garbage can (unlabelled, unweighed, and unpriced food; vegetable garden harvests; and disappearance through garbage disposals, pets, and compost heaps). Validity has not been measured.

In the school lunch program, total garbage analysis seems unnecessary given that the waste can be collected and separated before it becomes mixed in the garbage can. The small intrusion in the cafeteria environment can save many hours of trash separation that may entail large errors.

INDIRECT MEASURES OF WASTE

Food preference

For the purposes of this review, "food preference" is defined as an individual's opinion of a food in general, independent of such factors as alternative choices, quality of preparation, etc. "Food choice" is a measure of what an individual actually selects to be put on his or her plate. "Food acceptability" is considered to be the specific reaction to a food as prepared,

[31] Rathje, W.L. and G.G. Harrison. Monitoring trends in food utilization: application of an archeological method. **Federation Proceedings**, 1978, 37(1), 50–54.

[32] Harrison, G.G., W.L. Rathje and W.W. Hughes. Food waste behavior in an urban population. **Journal of Nutrition Education**, 1975, 7(1), 13–16.

served, and eaten. "Food consumption" is a measure of the amount actually ingested. These four concepts are generally related, but not necessarily highly correlated in all instances. For example, a food could have a high preference rating (be generally well liked) and not be chosen for a given meal because of an attractive alternative. It could also be chosen, then given a low acceptability rating because it was poorly prepared. Given all this, the actual amount consumed could also vary widely as a function of how hungry the individual is, when more food will be available, etc.

Preference can be measured by verbal ratings, nonverbal ratings, estimates of the frequency of desired consumption, and semantic differentials (Ellis, 1968).[33] In studies of children in the school lunch program, verbal hedonic scales such as the following have been most frequently used:

- "It's ok, I like it; It's a favorite; Never tasted it; Don't know what it is" on 4th to 6th and 9th grade children (Martin, 1971).[34]

- "Like very much" to "Dislike very much" (9-point scale) on 5th and 6th graders (O'Connor, 1975).[35]

- "Very pleasant; Pleasant; Neutral; Unpleasant; Very unpleasant" on nursery school children (Lamb and Ling, 1946).[36]

- "Terrible; Bad; OK; Good; Great" on grades 5 and 10 (Harper and Jansen, 1973;[37] Jansen, et al., 1975[38]); 4th to 6th and 10th to 12th graders (Head, et al., 1977);[39] and 5th graders (USDA/FNS, 1975(a);[40] USDA/FNS, 1975(c)[41]).

[33] Ellis, B.H. Preference testing methodology. **Food Technology**, 1968, **32** (May), 49–56.

[34] See footnote 25.

[35] O'Connor, M.A. Preference maximized school lunch menu planning. M.S. Thesis, University of Massachusetts, 1975.

[36] Lamb, M.W. and B. Ling. An analysis of food consumption and preferences of nursery school children. **Child Development**, 1946, 17, 187–217.

[37] See footnote 2.

[38] Jansen, G.R., J.M. Harper, A.L. Frey, R.H. Crews, C.T. Shigetomi and J.B. Lough. Comparison of Type A and nutrient standard menus for school lunch. III. Nutritive content of menus and acceptability. **Journal of the American Dietetic Association**, 1975, **66**, 254–261.

[39] Head, M.K., F.G. Giesbrecht and G.N. Johnson. Food acceptability research: comparative utility of three types of data from school children. **Journal of Food Science**, 1977, **42**, 246–251.

[40] USDA/FNS. Comparison of Type A and Computer assisted nutrient standard menus. Date County Public Schools. Contract No. 12–35–600–116, 1975(a).

[41] USDA/FNS. Comparison of Type A and Nutrient Standard Menus. Memphis City Schools. Contract No. 12–35–600–115, 1975 (c).

– "Like very much; Don't like; Have never tasted" on 4th graders (Hunt, et al., 1958).[42]

– "Like; Accept; Refuse" on preschoolers (as determined by their mothers) (Bryan and Lowenberg, 1958).[43]

– "Really good; Good; So-so; Bad; Really Bad" on 1st to 6th graders ("Determining ...", 1976).[44]

– "Will not eat; Will not choose; Will eat occasionally; Will eat frequently; Other" on young college women (Young and LaFortune, 1957).[45]

– "Like most; Like least of all; Have never tasted" on teenagers (Schorr, et al., 1972).[46]

Nonverbal hedonic scales for the measurement of preferences have included rating foods on a 1 to 10 scale ("Food ...", 1978)[47] and choosing which of a series of faces ranging from happy to sad best describes a food ("Determining ...", 1976;[48] LaChance, 1976(a)[49]).

[42] See footnote 9.

[43] Bryan, M.S. and M.E. Lowenberg. The father's influence on young children's food preferences. **Journal of the American Dietetic Association**, 1958, **34**, 30–35.

[44] Determining what's going down or out. **School Foodservice Journal**, 1976, **30** (Sept), 65–70.

[45] Young, C.M. and T.D. LaFortune. Effect of food preferences on nutrient intake. **Journal of the American Dietetic Association**, 1957, **33**, 98–103.

[46] Schorr, B.C., D. Sanjur and E.C. Erickson. Teen-age food habits. **Journal of the American Dietetic Association**, 1972, **61**(4), 415–420.

[47] Food preference surveys help cut plate waste. **School Foodservice Journal**, 1978, **32** (Sept), 21.

[48] See footnote 44.

[49] LaChance, P.A. Simple research techniques for school foodservice. Part I: Acceptance testing. **School Foodservice Journal**, 1976 (a), **30** (Sept), 54–61.

To determine preferences, a hedonic scale questionnaire is typically administered to children in their classrooms. In studies linking preferences to school lunch waste or consumption, the form is filled out just prior to the lunch when waste is to be measured. Usually a teacher administers the form and describes the foods listed. Food waste is collected after lunch and individual plate waste is weighed. A regression equation is computed between the preference rating and waste or consumption per 100 g. served (4 or 5 servings are used to compute mean serving size).

There are several problems with using preference ratings to measure plate waste. The first concerns reliability, that is, the capability of producing the same result twice from the same test on the same population. Although hedonic scales have been found to be reliable in determining preferences of adult men (Peryam and Pilgrim, 1957;[50] Jones, et al., 1955;[51] Waterman et al., 1974;[52] Meiselman, et al., 1972;[53] Smutz, et al., 1974[54]), preference ratings given by children have not been tested for reliability.

Children might be expected to produce unreliable preference ratings because their comprehension of food names has been shown to be poor ("Food ...", 1978;[55] Meredith, et al., 1951[56]). Many children do not have a food vocabulary as wide as their actual experience. If a teacher explains what a food consists of or looks like, the children are quite likely to be biased by the description. One investigator (Martin, 1971)[57] tested elementary school

[50]Peryam, D.R. and F. J. Pilgrim. Hedonic scale method of measuring food preferences. **Food Technology**, 1957, **11**, 9–14 (following page 472).

[51]Jones, L.V., D.R. Peryam and L.L. Thurstone. Development of a scale for measuring soldiers' food preferences. **Food Research**, 1955, **20**, 512–520.

[52]Waterman, D., H. Meiselman, T. Reed, L. Symington and L. Branch. Food Preferences of Air Force enlisted personnel. NARADCOM Technical Report 75–51–FSL, Natick, 1974.

[53]Meiselman, H.L., W. Van Horne, B. Hazenzahl and T. Wehrly. **The 1971 Fort Lewis Food Preference Survey**. NARADCOM Technical Report, TR–72–43–PR, 1971.

[54]Smutz, E.R., H.L. Jacobs, D. Waterman and M. Caldwell. Small sample studies of food habits: I. The relationship between food preference and food choice in naval enlisted personnel at the Naval Construction Battalion Center, Davisville, RI, NARADCOM, Natick, MA, 1974, Technical Report 75–52–FSL.

[55]See footnote 47.

[56]See footnote 6.

[57]See footnote 25.

children's familiarity with 33 food names by administering a pictorial and verbal matching test. Ninety-one percent of the foods were correctly identified by more than half of the students tested; more than 80% of the students identified 70% of the foods correctly. In the Junior High School, 12 food names were correctly identified by more than 85% of the students.

Evidence also shows that children may indicate ignorance about a food (vegetables in this case) that they are known to have eaten. When school lunch menus are filled with food names such as "vegetable chow", "tri-taters", "corn dogs", "pronto pup", French dip sandwich" and "succotash", it is not difficult to see why children often think they are not familiar with the foods listed.

A second problem with preference ratings is that if they are to be used as indirect measures of plate waste, then they must be validated. In this instance, the important aspect of validation is accuracy. There are reasons in addition to unreliability to doubt the accuracy of preference ratings as measures of plate waste.

When correlation coefficients have been computed between preference ratings and consumption or waste measures in school children, results have been equivocal. Some studies have failed to find a correlation (Hunt, et al., 1958).[58] Other studies have reported good correlations (Head, et al., 1977;[59] Jansen, et al., 1975;[60] Harper and Jansen, 1973;[61] Acredolo and Pick, 1975;[62] USDA/FNS, 1975 (a)[63] and (c)[64]), but did not present sufficient evidence to allow the reader to determine the error inherent in estimating consumption or waste from food preference data. Also, further research would be required to determine the variation in the relationship between preference ratings and waste over the different racial, socio-economic, geographic, and environmental conditions under which the method would most likely be used.

[58] See footnote 9.

[59] See footnote 39.

[60] See footnote 38.

[61] See footnote 2.

[62] Acredolo, L.P. and H.L. Pick. Evaluation of a school lunch program. **Psychological Reports,** 1975, **37**, 331–332.

[63] See footnote 40.

[64] See footnote 41.

An extension of food preference measures is to include a time dimension by asking students to give their preferred frequencies of eating specific foods (Ellis, 1968).[65] Sullins, et al., 1977[66] and Meiselman, et al., 1971[67] used this method to determine food preferences in adult men. Schuh and colleagues (1967)[68] attempted to measure the accuracy of adult hospital patients' preferred frequencies by measuring plate waste when foods were served at desired frequencies and more frequently, but failed to find a change in plate waste (estimated visually, but not validated).

O'Connor (1975)[69] and colleagues at the University of Massachusetts have attempted to determine a "preference-time function" – the abstinence period between occasions of eating a food, according to its degree of preference. They attempted to determine this function for 5th and 6th graders on 60 menu items. A 7-point happy face scale was used to determine preferences, and descriptions were used to simulate the time frame: "Pretend these foods are in front of you; how would you rate them? Pretend these foods are in front of you but you haven't eaten them since Christmas? How many times every 10 school days would you enjoy eating these foods?" The preference-time function, unfortunately, was not related to plate waste in the school lunch program but certainly offers an innovative method of tailoring school lunches to children's preferences.

In conclusion, studies of food preferences offer little support for using preference ratings as measures of waste. In addition to problems of unreliability and inaccuracy, it is clear from the literature (Ellis, 1968;[70] Pilgrim, 1961;[71] Peryam and Pilgrim, 1957[72]) that the terminology

[65] See footnote 33.

[66] Sullins, W.R., L.E. Symington, J.R. Siebold and J.G. Rogers. Food preference, acceptance, and consumption in a simulated, isolated-duty station. Natick, MA, NARADCOM, 1977. Technical Report Natick/TR–78/027.

[67] See footnote 53.

[68] Schuh, D.D., A.N. Moore and B.H. Tuthill. Measuring food acceptability by frequency ratings. **Journal of the American Dietetic Association**, 1967, **51**, 340–343.

[69] See footnote 35.

[70] See footnote 33.

[71] Pilgrim, F.J. What foods do people accept or reject? **Journal of the American Dietetic Association**, 1961, **38**, 439–443.

[72] See footnote 50.

used in the scales and the number of gradations require substantial pre-testing before being put into use. Although time and personnel requirements for administering and scoring preference questionnaires have not been reported, these would not seem to be significantly less than with other methods. A high degree of intervention is required, since students must individually complete the preference questionnaires.

Visual estimation

Visual estimation of plate waste is an appealing alternative to direct plate waste measures because it is cleaner, may be less time consuming, and may require fewer personnel. It entails evaluating the quantity of leftovers on a plate by sight, using a predesignated scale. In all studies reviewed here, the visual estimation scales were based on portion of the original serving which remained as waste. For example:

- 0, nothing eaten; 1, one bite eaten; 2, more than one bite eaten; 3, whole portion eaten (Acredolo and Pick, 1975)[73]

- 0, none; 1, some; 2, all of the food eaten (What's ...", 1971)[74]

- All; 3/4; 1/2; 1/4; none of the food remaining on the plate (LaChance, 1976(b))[75]

- 0; 1/2; 2/3; all food remaining on the plate (Chmielinski and White, 1978)[76]

The limited evidence available suggests that reliability of visual estimation measures can be good. Interobserver reliability was measured in two studies; it was found to be 88 to 93% by Acredolo and Pick (1975)[77] and 90% by Chmielinski and White (1978).[78] Test-retest scores were found by Chmielinski and White to vary from 8 to 26% for five specific foods.

[73] See footnote 62.

[74] What's wrong with school lunch. **School Lunch Journal**, 1971, May 1971, 42–51.

[75] LaChance, P.A. Simple research techniques for school food service. Part II: Measuring plate waste. **School Foodservice Journal**, 1976b, **30** (Oct), 66–76.

[76] Chmielinski, H.E. and M.A. White. Plate Waste Index: An observational measure/school food waste. Teachers College, Columbia University, 1978.

[77] See footnote 62.

[78] See footnote 76.

The biggest problem with visual estimation as a measure of plate waste is that its validity has not been established. Chmielinski and White conducted the only study to date which measured validity. The authors used a nonparametric method to compare visual estimates with the actual weights of the food waste. Agreement was 80%. One problem with the comparison is that only one tray was used to obtain the standard serving weights for each food item. Since serving sizes vary widely, it would be advisable to use a larger sample of trays to estimate serving sizes. Alternatively, visual estimates of plate waste could be based on an absolute scale such as volume so that estimates of waste do not depend on initial serving size.

A second problem with visual estimation is sampling. Unlike the other indirect methods, which might be able to collect data from all students, visual estimation would be done on only a sample of trays. As such, its validity is subject to the same factors of size and representativeness of samples which were discussed for individual plate waste.

Visual estimation appears to hold promise as a measure of plate waste, but it has not been tested extensively enough to permit its recommendation for use in a national study of school lunch waste.

Self-estimation of plate waste

A final indirect measure of plate waste involves asking students to give estimates of the amounts they consumed, for example, "all, most, about half, just tried it, none" (Head, et al; 1977).[79] Self-estimation as a measure of plate waste depends on the assumption that students will give accurate estimates of what they ate. Many studies suggest that this assumption is seldom true.

Head, et al; 1977 administered questionnaires to students in eight elementary schools and one high school asking the students to rate in adjacent columns how much they liked the food and how much they ate. Randomly selected plates were sampled for plate waste weighing. At low consumption levels, students claimed to have consumed more than they did.

Young, et al; (1953)[80] tested the food estimating capability of twenty-five 8th and 9th graders on three consecutive days during which the serving size and waste were measured, and students were asked to recall what they had just eaten for lunch. The agreement between recall and weighed values was "amazing" according to the authors, but close supervision by teachers could have made the students quite conscientious. In another study .6 children aged 12 to 14 years were unobtrusively observed during one lunch. Consumption was estimated by home economics teachers and the children were asked afterwards to recall what they had

[79] See footnote 39.

[80] Young, C.M., F.W' Chalmers, H.N. Church, M.M. Clayton, G.C. Murphy and R.E. Tucker. Subjects estimation of food intake and calculated nutritive value of the diet. **Journal of the American Dietetic Association**, 1953, **29**, 1216–1220.

eaten. A tendency for all children, but especially boys, to overestimate consumption was noted. Meat portions were found to be especially difficult to estimate. The investigators evaluated the accuracy of estimation and recall in several age groups and concluded that when the subjects knew they were being observed, their recall and estimation were better.

Meredith, et al. (1951),[81] in a similar study, asked 94 children nine to 18 years old to recall what they had eaten for lunch ½ to 2 hours after the lunch period. They were assisted by a nutritionist who knew nothing about the lunches that had been served. It was found that about 5% of the children remembered the number and kinds of items and their amounts correctly. One-third of the subjects remembered the number and kinds of foods, but almost one-half of the children forgot one to four items. The tendency to underestimate the volume of juice and applesauce consumed, for example, and to misidentify foods were some problems noted.

Another problem with procedures as obtrusive as self-estimation is that even if children's memory and estimation abilities are good, they may be biased in what they are willing to report. Marshall (1956)[82] and Litman, et al, (1964)[83] assessed children's food beliefs using the Lewin test. This is a questionnaire in which the child is asked which foods are bad and which are good, who punishes or praises his food behavior, and what are great and awful meals he might have at a friend's house. The results revealed that children know approximately what they should be eating, and that they tailor their alleged consumption to the adult they assume is reading their dietary reports.

Since self-estimation is subject to such large errors, it is not recommended as a measure of plate waste.

CONCLUSION

The seven methods reviewed above were evaluated as measures of plate waste suitable to be used in an economic analysis of the National School Lunch Program and School Breakfast Program. It is assumed that data will be collected on an institutional level, not necessarily separated by individual student. It is also assumed that specific food items will be kept separate. The method should be reliable and valid, and should be flexible enough for use with different serving systems, menu items, age groups, and geographic locations. Within these constraints, the method which best minimizes personnel, cost, and time requirements should be selected.

[81] See footnote 6.

[82] Marshall, M.M. An inquiry into the food attitudes characteristics of the children in the Menands school. M.S. Thesis, University of Massachusetts, 1956.

[83] Litman, T.J., J.P. Cooney, Jr. and R. Stief. The views of Minnesota school children on food. **Journal of the American Dietetic Association**, 1964, **45**, 433–440.

Four methods were found to be clearly unsuitable. Aggregate non-selective plate waste does not provide enough information about specific food items wasted. Garbage analysis involves allowing tray waste to become mixed in the garbage containers, necessitating the time-consuming procedure of separating the foods again. Food preference questionnaires were found to be of questionable reliability and validity as measures of waste. Self-estimation is subject to large student error and bias.

The three remaining methods are individual plate waste, aggregate selective plate waste, and visual estimation. Individual plate waste provides the most detailed information, but also requires the most time and expense. Aggregate selective plate waste seems more suitable because it can provide the same total waste measures without requiring individual weighings. Here the major unresolved methodological problem is how to obtain a sample of trays large enough and representative enough to give accurate estimates of the amount of waste in the whole cafeteria. Visual estimation shares this problem and also needs to be further tested for its accuracy.

Another valuable conclusion to be drawn from the literature reviewed here is that investigators need to be alert to factors consistently affecting plate waste. These are particularly relevant to the sampling among institutions and within institutions which must be done in measuring plate waste. Sex, age, serving style, choice, menu preferences, environmental temperature, season, and socio-economic status have all been mentioned as important variables for sample selection.

CHAPTER 3

PRELIMINARY OBSERVATIONS OF SCHOOL LUNCH PROGRAMS

DESCRIPTION OF SCHOOLS VISITED

A first step toward constructing an instrument to measure plate waste in schools is to examine the school feeding settings themselves. A total of 39 schools in Massachusetts and New Hampshire were visited. This sample was selected to reflect a variety of urban and rural conditions, school sizes, types of kitchen and food delivery systems, types of waste disposal systems, and student ages. The characteristics of the sample on thirteen relevant dimensions are shown in Table 1. These schools ranged from 130 students in a rural community school with family style feeding to 1900 students in an urban school with five separate cafeterias in the same building with on-site bulk feeding. The range of settings is just a suggestion of the considerable variability which must be considered in an analysis of NSLP plate waste.

The schools visited included 20 elementary schools, seven middle schools, and 12 high schools. Of the elementary schools, two served family style on-site; one served on-site, pre-packaged food; three served food prepared off-site in bulk; three served food prepared off-site and pre-packaged; and 11 served food prepared in bulk on-site. All 19 middle and high schools served food prepared on-site in bulk. Sixteen of the schools visited offered a breakfast to their students. The numbers of schools having each number of serving, eating and waste disposal locations are presented in Table 2.

Table 2. Number of Schools with Each Number of Locations
for Serving, Eating, and Waste

Number of Locations	1	2	3	4 or more
for serving	12	12	3	12
for eating	32	4	1	2
for waste	17	11	1	10

The number of students eating the full lunch in a single school ranged from 53 to 1900. The number of lunch shifts ranged from one to six, with three and four shifts being most common; and shift lengths ranged from 20 to 45 minutes, with 20 minutes being most common. Schools differed in the types of trays and/or plates used. The trays or plates were disposable in 10 schools, and nondisposable in 29 schools; in 31 of the schools, they were also compartmentalized. Finally, the methods of waste disposal differed according to item separation. Milk, food, and non-food were all mixed together in 15 schools. In the remaining 24 schools, at least one of these items was separated. The number of individual food item choices in a single school was also variable. The entrees available ranged from one to eleven. The number of vegetables served ranged from one to six, and the fruits offered ranged from none to four. Also, dessert choices ranged from none to four. The amount of variation in the factors which related to school feeding is tremendous, as indicated by the data above.

Table 1. Characteristics of School Lunch Programs Sampled
Elementary Schools

School Code #	Grade Range Served	Kitchen Type[a]	No. of Students Eating	No. of Separate Shifts	Shift Length in Minutes	Dishes or Trays: Dispos-able?	Dishes or Trays: Compart-mentalized?	Number of Serving Locations	Number of Eating Locations	Number of Waste Locations	Waste Separation[b]	Special Programs	Milk Choices[c]
1	K–4	1	293	2	40	No	No	2	1	1	3	No	W, S
2	K–4	1	120-160	1	30?	No	No	1	1	2	2	No	W,(C)
3	K–4	1	450	4	30	No	Yes	2	1	6	1	No	W,(C)
4	K–5	1	700	3	45	No	No	3	1	~10	6	No	W, C
5	K–5	1	200-400	3	30	No	Yes	1	1	1	6	No	W,(C)
6	1–5	1	335	5	20	No	Yes	2	1	1	1	Headstart in Classroom	W,(C)
7	K–6	1	210	3	35	No	No	2	1	2	2	Ticketed Choices	W, S
8	1–6	1	53	1	Till Done	No	Yes	1	3	3	6	No	W,(C)
9	1–6	1	126	2	20	No	Yes	1	1	1	2	No	W
10	K–8	1	420	4	30	No	Yes	2	1	1	3	No	W
11	K–8	1	116	2	25	No	Yes	1	1	1	2	No	W
12	K–6	2	126	1	30	No	Yes	10	1	1	2	Family Style	W
13	1–6	2	130	1	20	No	No	Each Table	1	1	4	Family Style	W, S
14	K–6	3	337	Continuous Feeding	30	Yes	Yes	1	1	2	2	No	W
15	K–6	3	300	3	25	Yes	Yes	1	1	1	1	No	W
16	K–6	3	75	3	30	No	Yes	1	1	1	1	Ticketed Choices	W, S
17	K–5	4	220	4	45	Yes	Yes	6	6	6	1	No	W
18	K–5	4	220	4	20 min. (20 min. recess)	Yes	Yes	1	1	2	1	No	W, C
19	K–6	4	90-95	2	30	Yes	Yes	1	1	1	2	No	W
20	1–6	5	150	4	20	Yes	Yes	1	1	1	1	On-Site Pre-Pack	W

[a]Kitchen and Serving types: 1 = on-site, bulk; 2 = on-site, family; 3 = off-site, 4 = off-site, prepackaged; 5 = other.

[b]Waste kept mostly separate (milk, food, nonfood): 1 = (MFN) all mixed together; 2 = M(FN) milk in a bucket; 3 = F(MN) food scraped; 4 = N(MF) milk & food combined; 5 = (MN) (FN) milk & cartons, food & paper; 6 = MFN all separated; 7 - not known or other

[c]Milk choices available
W = Whole   C = Chocolate   S = Skim   Choices in parentheses were only available on some days.

Table 1. Characteristics of School Lunch Programs Sampled (cont'd)

Middle & High Schools

School Code #	Grade Range Served	Kitchen Type[a]	No. of Students Eating	No. of Separate Shifts	Shift Length in Minutes	Dishes or Trays: Dispos-able?	Dishes or Trays: Compart-mentalized?	Number of Serving .ocations	Number of Eating Locations	Number of Waste Locations	Waste Separation[b]	Special	Milk Choices[c]
21	4–8	1	950	4	23	No	Yes	8	2	2	4	Salad Bar	W, C
22	5–8	1	450	4	20	No	Yes	1	1	1	4	Elderly Feeding	W
23	5–8	1	500	4	30	No	Yes	2	1	2	1	Soup & Sandwich Line	W,S(C)
24	6–8	1	450	3	20	No	Yes	1	1	1	1	No	W, C
25	6–8	1	610	3 or 6	25 or 20	No	Yes	2	1	2	1	No	WS, C
26	7–8	1	432	4	20	No	No	2	1	1	1	No	WS, C
27	6–9	1	450-500	3	25	Yes	Yes	2	2	2	7	No	W
28	7–12	1	700-800	4	25	No	Yes	3	1	7	5	Self-Serve	W, C
29	7–12	1	398	4	23	No	No	2	1	1	6	O vs. S[d]	W, S
30	7–12	1	1800	3	20	Yes	Yes	2	1	6	1	O vs. S	W
31	9–12	1	1900	3	25	Yes	Yes	4	4	4	4	Compactors	C,W, S
32	9–12	1	800	4	20	No	Yes	4	1	2	2	O vs. S	W
33	9–12	1	1700	3	25	No	No	4	2	1	4	Salad Bar A La Carte	W,C,S
34	9–12	1	1400	3	40	No	Yes	3	1	2	4	O vs. S	W, C
35	9–12	1	1100	3	22	No	Yes	4	2	2	4	Salad Bar	W, C
36	9–12	1	1500	4	25	No	Yes	5	1	8–9	1	No	W, S
37	9–12	1	900	2	35	No	Yes	4	1	4	4	Snack Bar O/S	W
38	9–12	1	1200	3	25	No	Yes	5	1	13	1	O vs. S Scatter-Serve	W
39	10–12	1	350	2	38	Yes	Yes	2	1	4	1	O vs. S	W

[a]Kitchen and Serving types: 1 = on-site, bulk; 2 = on-site, family; 3 - off-site, bulk; 4 = off-site, prepackaged; 5 = other.

[b]Waste kept mostly separate (milk, food, nonfood): 1 = (MFN) all mixed together; 2 = M(FN) milk in a bucket; 3 = F(MN) food scraped; 4 = N(MF) milk & food combined; 5 = (MN)(FN) milk & cartons, food & paper; 6 = MFN all separated; 7 = not known or other

[c]Milk choices available
W=Whole C = Chocolate S = Skim Choices in parentheses were only available on some days.

[d]Offer vs. Serve

The selection of schools in Massachusetts and New Hampshire at the end of the school year raises some critical issues for the interpretation of the data. It is important to recognize that sampling done in this region, at this particular time, may have yielded data which are not strictly representative of the national constituency of the NSLP. For example, the menus sampled in some cases reflect changes in menu planning strategies from the normal procedure. This point was made by some of the cafeteria managers who stated that they were preparing for the end of the school year by incorporating perishable stored foods into the menus for that period. Other effects of time of the year, such as field trips, early dismissals, and special uses for cafeterias (e.g., play rehearsals) are not likely to have biased the observations. Nonetheless, it must be recognized that limitations exist in the generality of this sample.

Another focus of our observations was to anticipate any problems that might arise for measuring plate waste in these school settings. This task was incorporated as a standard component of the field observations. The possible measurement difficulties and sources of error were broken down into: (1) variable quantities of foods served to students; (2) variable quantities of food wasted; and (3) other extraneous sources of consumption and waste variability not directly related to menu, delivery system, or waste disposal system. An outline of these problems is presented in Part 2 of this section.

It is clear from the outline that the goal of large scale, objective measurement of plate waste in settings and with populations exhibiting such enormous variability is a most difficult task. The method to be used must be inexpensive in personnel, time, and general overhead costs, as well as valid. This means that the measurement procedure must be flexible enough to accommodate the highly variable physical environments and serving systems, and that it must yield data from each setting which are reliable, valid, and still comparable for use in the overall economic analysis. Thus it appears that a single, invariant procedure may not be feasible. What is needed instead is a standard protocol for data recording, and a set of procedures which will control for any observed variability in the system, and which can be used in all settings concerned.

WASTE MEASUREMENT PROBLEMS

I. How Much Each Student Was Served May Be Difficult to Assess because

A. Food service workers serve portions of varying size.

1. Random variability

a. Size of naturally-portioned items

- Fresh fruit (apples, bananas, oranges) and sometimes canned fruit (pears) are served whole (or halved). Fruits are naturally variable in size.

- Meat is also sometimes naturally portioned (chicken pieces, fish pieces), though more often served in a more uniformly-portioned way (fishcakes, hamburger patties).

b. Method of preparation

- Toppings (frosting, whipped topping, sauces, condiments) may be thicker on some portions than on others.

- Cutting is a great source of variability, particularly for sheet cakes, large pizzas (at least for edge pieces), vegetable sticks (carrots, celery), salad ingredients (tomatoes), etc.

- Bread was usually commercially sliced into very uniform pieces. The exception is school-baked rolls (and cookies), which could be moderately variable in size.

c. Method of serving

- Serving utensils vary in their accuracy from

  – measured ladles (e.g., 4 oz or 6 oz, used by most schools for at least some items, such as spaghetti, soup, stew)

  – ice cream scoops (sometimes used for other items such as mashed potatoes or cole slaw)

  – slotted spoons (used by most schools for serving vegetables)

  – regular servings spoons (used occasionally for items such as turkey a la king, vegetables, cole slaw)

- rubber spatulas (often used, sometimes by students, to spread condiments like mustard)

- metal spatulas (often used to serve pizza, lasagna, cakes)

- scoops (sometimes used for french fries, salad)

- tongs (used rarely, for items such as fish sticks, salads, French fries)

- hands (extremely variable when used to serve French fries, potato chips)

- paint brush (sometimes used by food service workers to put butter (melted) on bread)

- squirt bottle (occasionally used for condiments)

- Food service workers cannot perfectly size the portions they serve.

- Preportioned items are probably less variable in serving size than items portioned as served.

2. Systematic variability

a. Age of student

- Older students were frequently given larger servings or seconds.

b. Size of student

- Bigger students were frequently given larger servings or seconds.

c. Students' requests for more or less

- Some schools freely adjusted portion size in accordance with student requests, some even to the point of omitting an item entirely if a student requested.

- Even prepack lunches were occasionally given as seconds if there were extras.

d. Food service workers seemed to adjust serving sizes as a meal progressed, either to conserve items in short supply or to use up items in ample supply.

e. Food service workers occasionally portioned items visually (e.g., 2/3 of a dish full). If more than one size of dish or compartment was used, portion size would also vary.

B. Students may select portions of varying **size**.

1. Amount of self-selection within a preportioned menu item.

   - Schools often allow students to select their own items (pick up own vegetable sticks, cakes or other desserts, fruit, sandwiches, rolls, etc.). Students can thus choose smaller or larger portions (and often appear to carefully ponder their choices).

2. Self-serve items.

   - Portion size is obviously enormously variable when students spoon (or otherwise dish up) their own food.

   - Self-serve happens most frequently with condiments and salad dressings. Occasionlly schools allow self-serve on most menu items (either in the regular line or on a salad bar).

3. Family-style service allows great variability in individual portion size, since all items are self-served from serving dishes at the dining tables.

C. Students may select menus of varying composition.

1. Offer vs. serve

   - High schools sometimes (and middle schools, occasionally) allow students to purchase a Type A lunch with only three or four of the five food items included.

2. Amount of choice available

   - Some schools (particularly, but not exclusively, high schools) offer choices within menu categories.

     – Milk: always white, sometimes chocolate, infrequently skim

     – Entrees: probably the item with the fewest choices, unless fast food or cold sandwiches

     – Vegetables: sometimes leftovers from previous days. Greatest choices probably occur in salad bars

     – Fruits: frequently choices of several different canned or frozen fruits

     – Potato: seldom more than one variety served

– Bread: usually only white, but rarely whole wheat or other dark bread also

– Other desserts: sometimes a choice of type of cookie or cake

3. Extra portions and a la carte items

• Schools had widely different procedures for serving extra portions. They ranged from:

– Extra portions only if a second full meal is purchased (as the student goes through the line or later)

– A La Carte items purchased separately (milk, potato chips, etc.)

– Extra entrees distributed to students who want them free of charge

• Sometimes vending machines or carts sold extra items during the lunch period (ice cream bars, soft drinks)

D. Food may be traded.

1. Items from the Type A lunch

• Student trading was more common in some schools than others.

• Occasionally, lunch monitors encouraged trading by looking for students to eat other students' leftover food items.

2. Other food

• Students may occasionally trade food from the Type A lunch for food from brown bag lunches.

II. How Much Students Ate (Wasted) May Be Difficult to Assess because

A. Food goes other places than waste containers.

1. Outside the lunchroom

• Students often take food to playgrounds and elsewhere (bathrooms, classrooms), even though most schools prohibit it.

• Food service workers reported particular problems with fresh fruit in the plumbing and peanuts and raisins being thrown.

2. Onto tables and floors, etc.

    - This problem was usually fairly small, with a few notable exceptions

3. Sometimes some groups eat Type A lunch someplace other than the lunchroom.

    - Special ed students, preschoolers, kindergarten, were observed to eat separately in their classrooms.

    - At some schools, students eat outside.

B. Other waste is included in the same containers.

1. Brown bag lunches

    - Occasionally students who brought lunches from home sat in a separate area of the lunch room.

2. A la carte

3. Teachers, food service workers

4. Non-food waste

    - Prepack trays (hot & cold packs).

    - Napkins, milk cartons, & other disposables.

    - Plates, trays, silverware are occasionally discarded by mistake.

C. Waste separation is never complete.

    - Even when students are supposed to separate items, they often make mistakes or don't complete the separation.

    - Hard to separate chicken meat from bones, apples from core, etc.

    - Liquid foods and sauces which mix will be difficult to separate.

    - Some solid foods (e.g., breads) may absorb liquid and result in contamination of both.

D. Pricing policies may encourage the purchase of extra meals to obtain one item

    - e.g., students may want to purchase a second whole Type A lunch just to get a second serving of French fries, which cannot be bought a la carte.

III. Other Measurement Considerations Come from the Following

A. Time influences measurement on several levels.

1. Time of meal

- Portion size may change from the initial package through cooking, etc.

2. Time of day

- Students tend to be hungrier for the later shifts, and if lunch is after recess.
- Students may rush to finish if recess follows lunch.

3. Time of week

- Many schools have special menus certain days of the week (meatless Fridays, chocolate milk on Tuesdays & Thursdays, etc.).
- One school had half days every Wednesday, so lunch was limited that day.

4. Time of year

- Seasonal diet variations may occur, such as more hot soups in the winter and more fresh vegetables in late spring and early fall.

5. Special days

- Field trips (more numerous in the late spring) and other special meals may cause major disruptions in the lunch program

6. Duration of lunch period

- Time for measurement may be limited.
- Time for students to eat may not always be sufficient.

B. Space is often limited.

1. Unobtrusive measures are unlikely.

- Although there is usually enough space to physically observe kitchen, serving, eating, and waste disposal functions, there is usually no place to do this observation without being very noticeable to kitchen staff and students.

2. Lunch rooms often have other uses.

- Cafetoriums, study halls, gyms, classrooms were all frequently observed. These other uses could possibly be disrupted by observers, especially when they occur simultaneously with lunch, as did one study hall and one singing class.

C. Menus vary widely in popularity and familiarity

- Food service workers reported that the most popular menu items were pizza, hamburgers, French fries, spaghetti, etc.; least popular were vegetables.

D. Tray reserves might not be available for use between shifts.

CHAPTER 4

PROPOSED METHOD – AGGREGATE SELECTIVE PLATE WASTE

RATIONALE

The review of the literature on methods of measuring plate waste narrowed the options appropriate for a national economic study to three: individual plate waste, aggregate selective plate waste, and visual estimation. Preliminary observations in the schools did not specifically prohibit the use of any of these methods. All three appear to be applicable to each type of food preparation, serving, and waste disposal system, kind of menu, school size, etc., with only minor variations. None of the methods would drastically modify school lunchroom routines, and the required equipment is simple and readily available.

Aggregate selective plate waste is the method recommended by the NARADCOM research team. The rationale is as follows. Time and cost are important criteria in the choice of a method. Individual plate waste, while it provides the most detailed information about waste, is the most time-consuming method. In some preliminary comparisons of the time required to scrape and weigh plate waste, individual plate waste indeed required more time than did aggregate selective plate waste. Since information on amounts of food wasted by individuals is not essential for an economic analysis of feeding programs at the school level, the extra time and associated costs involved make individual plate waste a less appropriate measure.

Aggregate selective plate waste was also judged better than visual estimation for purposes of an economic analysis. There are four basic reasons for this judgment. The first is that visual estimation has not been adequately tested for accuracy. An economic analysis would seem to require accurate measurements of the absolute waste. Although the studies of visual estimation reviewed in Chapter 2 showed high inter-observer agreement, the accuracy of visually estimating the weight of waste has not been adequately tested. Second, since visual estimation has been based on proportion of the initial serving that was wasted, it would be expected to be particularly inaccurate in lunch programs which serve portions of varying sizes. Since initial serving sizes are typically highly variable, relatively lower accuracy of the estimates would be expected. A different visual estimation procedure based on volume of waste rather than proportion might reduce this problem, but it would be a time-consuming and costly method to develop. The third and fourth disadvantages of visual estimation are based on judgments by the NARADCOM research team that visual estimation would require much more staff training and would take no less time at each school.

ASSESSMENT OF INDIVIDUAL PLATE WASTE VARIABILITY

It is expected that the application of aggregate selective plate waste measures to the economic analysis of the school lunch program will involve selectively scraping only a sample of the trays from a meal. Although at small schools it may be possible to scrape waste from all trays, time and personnel constraints will make sampling a necessity at larger schools. Two major questions are raised when sampling is employed. First, how many trays can a team of researchers be expected to scrape in a given amount of time? The literature reviewed gave little indication of the time and personnel requirements of aggregate selective plate waste measurement.

A second unanswered question concerns the accuracy in estimating total waste when only a sample of trays is aggregated. Obviously, if waste from all trays is aggregated, then total plate waste for each food item is known with as much accuracy as the scraping and weighing procedures allow. When sampling is employed, total waste must be estimated from the total waste in the sample. Assuming that an unbiased sample is obtained, the accuracy of the estimate depends on three factors:

1. The number of trays in the sample (n),

2. the number of trays in the lunchroom population (N), and

3. the variability of the waste of each food item across trays.

Estimates of total waste of a food item will be worse the smaller the sample size, the larger the population size, and the larger the variability in food item waste. Ideally, a large enough sample size should be chosen so the estimates of total waste in most food items will meet some established criterion of accuracy. This cannot be done unless variability in individual plate waste is known. No data on plate waste variability were found in the literature.

The data described below were gathered to measure variability in individual plate waste for a variety of menu items. Aggregate selective plate waste was also measured for samples of trays in order to begin to assess time requirements and develop the recommended sampling and scraping procedures.

METHOD

Sites

Since the analysis of individual plate waste variability was made during July and August, no regular school lunches were being served. Two summer programs with feeding systems similar to schools participating in the NSLP were selected. Both programs served lunches that met the specifications for type A lunches, both served students of similar numbers and ages, and both had lunchroom procedures similar to those observed during the school year. Program supervisors were very cooperative in allowing data to be gathered in the lunchrooms.

Program A was a summer recreation and community school program located at an urban elementary school. Approximately 165 children between the ages of 6 and 12 were fed cold, prepackaged lunches which had been prepared by a private, off-site vendor. There were no choices available in menu items. All trays and utensils were disposable. The children ate in groups of eight or fewer at round tables and usually disposed of their garbage in waste containers scattered around the lunchroom.

Program B was a pre-college enrichment program for approximately 361 gifted high school students, ages 13 to 15. Lunches were prepared on site and served in bulk from the cafeteria

line of a state college dining facility. Two hot entree choices were available each day, and there was a very popular self-serve salad bar. Trays and utensils were not disposable. Students ate at round tables for six. They separated utensils and paper from their trays before placing them on a conveyor belt leading to the dishroom.

Plate sampling and scraping procedures

Each site was visited on two days (A1, A2, B1, B1); the second visits were five days after the first visits to each site. The research team of three or four people arrived before lunch was served, set up equipment, and recorded the menu items to be served that day. At site A, five lunches were randomly selected and the initial serving sizes of all menu items were weighed. It was not possible to weigh initial servings at site B.

When students had completed their meals, a sample of trays was gathered for weighing. Even though lunchroom routines necessitated a slightly different procedure at each site, the sampling procedures were designed to be unbiased. At site A, students were instructed by the lunchroom monitor to leave all their waste on the tables. When the students left the lunchroom at the end of the meal, the research team gathered all the trays, putting every second tray from each table into a group for aggregate scraping. The other half of the trays were selectively scraped and the scrapings were individually weighed.

At site B, trays were picked from the conveyor belt. On day one, every fourth tray was sampled, and on day two, every third tray was sampled. The first tray sampled was randomly chosen from among the first three or four trays. As at site A, every second sampled tray was put into a group for aggregate scraping and the remainder were individually scraped and weighed.

Sampled trays were selectively scraped as follows. The basic procedure was to separate for weighing all the edible portion of each food item which remained on student trays. Nonfood waste and inedible food waste were discarded. For example, banana was weighed without the peels and chicken without the bones. Individual food components were separated from each other as much as possible without excessive labor. For example, hamburger and cheese were separated from buns and as much condiment as possible was separated from the meat and buns; gravy was separated from green beans, turkey, and bread. In these difficult separations, there was some small and unavoidable contamination of one food item from another. Some food items were intentionally left as composites, for example, macaroni and cheese (B1), soup (B2), lettuce with dressing (B1), and mixed tossed salad with dressing (B2).

Equipment and procedures for weighing

All weights were measured to the nearest 0.1 grams using a Mettler P–1000 top-loading scale, which could weigh up to 1000 grams. The scale was balanced at each site prior to data collection.

Food waste to be included in aggregate weighings was scraped with rubber spatulas into separate containers, one for each food item. The containers were of three types – number 10

can with plastic lids, gallon-size Ziploc plastic bags, and 250 ml polystyrene disposable dishes (Moore-Park weigh boats). The empty weight of each number 10 can was determined and recorded prior to the collection of any food waste. After all trays had been selectively scraped, the aggregates were weighed and container weights were subtracted. An empty plastic bag or weigh boat was placed on the scale and the scale set to zero prior to weighing aggregates in those container types.

For the measurement of individual plate waste, the scale was set to zero with an empty weigh boat in place. Food items from individual trays were then selectively scraped into separate weigh boats and weighed. Weights from one tray were recorded before moving on to items from another tray. When a tray showed no evidence of a food item, either because the food had been completely consumed or because the food had never been on the tray, the weight was recorded as zero.

The times required to weigh individual plate waste and aggregate selective plate waste were informally measured with a stop watch during portions of the first three days of data collection. On the final day, procedures were kept as close as possible to those expected to be employed in the final method. One researcher sampled and delivered trays to a second researcher, who selectively scraped for aggregate selective plate waste. The time from a stopwatch was recorded after each ten trays.

RESULTS

Table 3 shows the number of trays at each site on each day that were sampled for aggregate selective plate waste and for individual plate waste. Also shown are the total numbers of trays served at each site. At site B, the total number of meals served was estimated by multiplying the number sampled by the inverse of the proportion of trays sampled.

Table 3. Number of Trays Sampled for Weighing On Each Day At Each Site

	SITE A		SITE B	
	Day 1	Day 2	Day 1	Day 2
Aggregate selective plate waste	40	40	37	55
Individual plate waste	42	40	37	52
Total trays served	130	80	296	321

Plate waste data were gathered for a total of 36 food items, 12 at site A and 24 at site B. Waste was weighed for all food items served at site A. At site B, a few foods offered were ignored in the waste collection. On day 1, no data were collected on beverages; waste from the fruit drink served at site B was measured on day 2. Also, on day 1, no waste occurred in three items which were to have been measured – pickles, macaroni salad, and cucumbers – which were all available on the salad bar. On day 2, at site B, three food items that were very seldom wasted – milk potato chips, and ketchup – were ignored, as were peas, which were introduced to the cafeteria line late in the meal. Cottage cheese waste was to have been measured, but none occurred.

The 36 food items for which waste measurements were made are listed and described in Table 4. Also listed are initial serving weights for all items served at site A and for seven items served at site B. At site A, the weights listed are the means of five initial servings. The weights listed for site B were obtained when portions returned as waste could be determined to be a full serving.

Individual plate waste

Table 5 lists several characteristics of the wasted food items from the individual plate waste measurements at each site. The mean waste weight in grams is the mean amount of each food item returned per tray. Since the sample of trays was obtained in an unbiased way (every xth tray was sampled), multiplying the mean waste by the number of students in the lunchroom will provide an estimate of the total waste produced in the lunchroom for a given food (see Cochran, 1953).[84] For example, the mean corned beef waste was 31.6; multiplying by 130, the number of trays served at site A on day 1 (see Table 3), yields an estimated total waste for corned beef of 4108 grams. Estimating total waste from the mean will be unbiased in that it will not predictably overestimate or underestimate the lunchroom total. It will also be a consistent estimator, meaning that the estimate will be better the larger the sample size.

Table 5 also lists the variance of each food item, calculated from the individual plate waste samples. Food items differed tremendously in variance, ranging from 0.6 grams squared for bacon to 6826.6 grams squared for milk. Variability can be indexed in three other ways particularly relevant to assessing the accuracy of sampling food waste from a large finite population. There are:

1. the number of trays needed for the sample to meet a specified criterion of accuracy,

2. the standard error of the mean (or total) waste in grams, and

3. the standard error of the total waste in dollars.

Each of these measures is treated below.

First, it might be asked how many trays would need to be sampled for the estimated total waste to meet a given criterion of accuracy. The criterion chosen here was a standard error of the mean no larger than 10% of the mean. Since the total number of trays served is known, the standard error of the **total** waste will also be no larger than 10% of the total waste. When this criterion is met, the true lunchroom total waste for a given food item would be expected to fall within plus or minus 10% of the estimated total for approximately two-thirds

[84] Cochran, W.G. Sampling Techniques. New York: Wiley, 1953.

Table 4. Description of Food Items for Which Individual Waste Measurements Were Made

Food Item	Description of Item	Mean Serving Weight in Grams[a]
Site A, Day 1:		
Corned Beef	Thin-sliced heap for bun filling	56.2
Bun	Hamburger roll for Corned Beef	49.1
Cole Slaw	Chopped cabbage with dressing	83.1
Banana	Small, fresh	67.4
Milk	White, in carton	238.2
Mustard	Prepackaged	3.9
Site A, Day 2:		
Chicken	3-5 fried, cold, 2nd wing joints	58.8[b]
Roll	Small unbuttered dinner roll	25.1
Banana	Small, fresh	75.7
Milk	White, in carton	240.9
Orange Juice	Natural, in carton	121.9[c]
Ketchup	Prepackaged	6.1
Site B, Day 1:		
Bacon	Strips	
Macaroni & Cheese	Large serving, approx. 1½ cups	
Bread	Sliced, white	22.1
Potato Chips	On salad bar, ruffled	
Green Beans	Cut	
Green Pepper	On salad bar, chopped	
Tomato	On salad bar, sliced/chopped	
Onion	On salad bar, sliced	
Lettuce with dressing	On salad bar, shredded, 3 dressings	
Jello	Red and green cubes	
Cookies	Chocolate chip, oatmeal, sugar	15.2

Table 4. Description of Food Items for Which Individual Waste Measurements Were Made (cont'd)

Food Item	Description of Item	Mean Serving Weight in Grams[a]
Site B, Day 2:		
Hamburger	Patty served on bun	47.2[d]
Turkey	One rolled piece, hot	51.8[d]
Cheese	Sliced American, on salad bar, for hamburger	
Bun	For hamburger	53.5[d]
Bread	Sliced, white, for turkey	
Gravy	Ladled onto hot turkey	
Soup	Vegetable beef in cup	
Green Beans	Cut	
Cold Slaw	On salad bar, chopped cabbage with dressing	
Mixed Tossed Salad	On salad bar, lettuce, tomato, radish & onion	
Mixed Fruit	Canned peaches, pineapple, fruit cocktail	
Fruit Drink	Red, orange, green, purple	197.2[d]
Cookies	Six different kinds	14.2

[a]Weights of Site A items based on initial servings. Weight of Site B item obtained only when complete portions were returned as waste.

[b]Chicken bones were not weighed in waste measurements.

[c]Weighed including carton.

[d]Based on only one observation.

Table 5. Means and Variances of Individual Plate Waste, and Sample Sizes Required for Standard Errors to be Within 10% of the Mean

Food Item	Mean Waste In Grams	Variance*	Sample Size Required for Population Size = 100	500	1000	2000
Site A Day 1:						
Corned Beef	31.6	561.8	37	51	54	55
Bun	29.1	497.9	38	53	56	58
Cole Slaw	68.2	1024.5	18	22	22	22
Banana	11.9	525.9	79	214	272	315
Milk	36.6	6461.5	83	246	326	389
Mustard	2.2	4.2	47	74	80	83
Site A Day 2:						
Chicken	16.6	286.4	51	86	94	99
Roll	9.8	202.3	68	148	174	190
Banana	17.5	796.2	73	172	207	231
Milk	36.2	6826.6	84	256	343	414
Orange Juice	6.2	459.4	93	351	541	714
Ketchup	5.8	4.9	13	14	15	15

*Variance = $\Sigma(x - \bar{x})^2/(n-1)$

Table 5. Means and Variances of Individual Plate Waste, and Sample Sizes Required for Standard Errors to be Within 10% of the Mean (Cont'd)

Food Item	Mean Waste In Grams	Variance*	Sample Size Required for Population Size = 100	500	1000	2000
Site A Day 1:						
Bacon	0.3	0.6	90	320	471	615
Macaroni & Cheese	28.8	3801.3	83	240	315	374
Bread	6.2	120.2	76	193	238	270
Potato Chips	0.6	5.8	94	375	600	856
Green Beans	14.9	756.9	78	204	255	293
Green Pepper	0.4	1.4	92	342	518	699
Tomato	2.8	68.5	90	316	461	599
Onion	0.5	1.6	86	269	368	450
Lettuce w/dressing	11.6	554.5	81	225	291	340
Jello	15.9	1186.4	83	243	321	382
Cookies	7.3	246.3	83	242	319	379
Site B Day 2:						
Hamburger	6.9	179.5	79	214	272	315
Turkey	1.1	51.5	98	447	807	1353
Cheese	0.6	4.3	94	370	587	830
Bun	8.7	221.9	75	186	228	258
Bread	2.3	90.1	95	383	620	899
Gravy	2.2	37.1	89	302	432	551
Soup	2.1	202.8	98	451	820	1390
Green Beans	32.5	421.2	29	37	39	40
Cole Slaw	1.8	170.7	99	457	839	1446
Mixed Tossed Salad	8.3	454.8	87	284	396	494
Mixed Fruit	6.7	351.9	89	305	439	563
Fruit Drink	7.0	817.1	95	386	627	913
Cookies	1.9	37.6	91	335	503	671

*Variance = $\Sigma(x - \bar{x})^2/(n - 1)$

of the samples drawn. Table 5 lists the number of trays required for the sample when the total number of trays served is 100, 500, 1000, and 2000. The formulas used to calculate sample sizes were as follows (Kish, 1965).[85] First, the element relative variance, c_Y^2, was calculated as $s_Y^2/\bar{Y}^2$, where s_Y^2 is the variance and $\bar{Y}^2$ is the squared mean. The relative variance of the mean, or the coefficient of variation, cv^2, was set at $0.1^2 = 0.01$. The sample size needed for cv^2 to be 0.01 in an infinite population was calculated as $x = c_Y^2/cv^2$. Correcting for finite populations of known size N, requiring sample sizes were then computed by the formula $n = x/(1+x/N)$.

Notice that as population size increases, the sample size required to meet the accuracy criterion also increases, but not nearly as rapidly. This means that the proportion of trays required to meet the accuracy criterion decreases as population size increases. For example, at population size 100, 30 of the 36 food items would require sampling more than half of the trays, while at population sizes 500, 1000, and 2000 only 17, 10, and 3 of the 36 food items would require sampling more than half of the trays.

In general, the food items requiring the largest sample sizes are the food items of which the smallest percent was wasted. This relationship between percent wasted and sample size required was remarkably strong. Table 6 shows the food items measured at site A, rank ordered by approximate percent of the serving size which was wasted. Also shown are the sample sizes required in a population of 500 for the standard error of the total to be within 10% of the mean. Of the 12 items, there are only two (chicken and roll) which are out of order by one location. The Pearson product-moment correlation coefficient is -0.88.

The inverse relationship between percent wasted and sample size required has practical significance. It indicates that the food items for which the waste will be easiest to estimate (i.e., a satisfactory estimate can be obtained with the fewest trays sampled) are the food items which are in some senses the most important to estimate accurately, those for which the most waste occurred.

Another characteristic of waste measurement is apparent from the data on sample sizes required to meet the criterion of a standard error of the total within 10% of the total. In general, smaller sample sizes are required at site A than at site B. For example, in a population of 500 at site A, only one food (orange juice) of the 12 measured would require a sample size of more than 300 students. At site B, 13 of the 24 foods measured would require a sample size of more than 300 students. The explanation of this difference is that at site B there was a wide range of menu choices available. No attempt was made to keep track of which menu items were served to which students. The absence of waste from a given food item was always recorded as zero, whether no food had been taken or whether the food was all consumed. Using this procedure, when a food is one of several choices, the distributions of individual plate waste tend to include many zeros, to be biomodal or positively skewed, and to have low means and high relative variances. Such distributions require larger sample sizes for estimates of total waste to meet criterion.

[85] Kish, L. Survey Sampling. New York: Wiley, 1965.

Table 6. Approximate Percent Waste of Food Items at Site A and Sample Sizes Required for the Standard Errors to Be 10% of the Mean In a Population of 500

Food Item	Day	Approximate % Wasted	Sample Size Required When n = 500
Ketchup	2	95	14
Cole Slaw	1	82	22
Bun	1	59	53
Corned Beef	1	56	51
Mustard	1	45	74
Roll	2	39	148
Chicken	2	28	86
Banana	2	23	172
Banana	1	18	214
Milk	1	15	246
Milk	2	15	256
Juice	2	5	351

A second and closely related way to consider the accuracy of sampling is to estimate standard errors of the mean waste in grams for specific sample and population sizes. The two sample sizes chosen were 150 and 300 trays, and population sizes were 500, 1000, and 2000. Tables 7 and 8 show the standard errors of the mean, expressed in grams and also as proportions of the mean waste, which would be expected at each sample and population size. Figure 1 graphically illustrates the decrease in standard errors expected for increasing sample sizes in population of 100, 200, 500, and 1000.* The two foods illustrated are milk (A1), with a high gram standard error and hamburger (B2) with a lower gram standard error. Standard errors expressed as proportions of the mean were approximately equal for the two foods.

Notice that, for constant sample and population sizes, food items vary widely in the accuracy of estimates which would be obtained. Standard errors expressed in grams are not necessarily correlated with standard errors expressed as proportions of the mean. For example, suppose 300 trays were sampled in a lunchroom of 500 students. For milk at site A, the standard error of the mean waste would be expected to be about 3 grams (or 1500 grams for the total waste), or about 8% of the mean (or total). The standard error of the mean for cookies (B1) was approximately the same proportion (0.08) as for milk, but it was only 0.57 grams. Soup (B2) had a standard error of the mean of 0.52 grams, similar to cookies, but this standard error was 25% of the mean soup waste.

Tables 7 and 8 also show that for a given sample size, doubling the population size (e.g., from 500 to 1000 or from 1000 to 2000) results in only slight increases in standard errors. On the other hand, for a given population size, doubling the sample size from 150 to 300 decreases standard errors by nearly one half. Therefore, a sample of 300 trays would be expected to provide much better estimates of total waste than would a sample of 150 trays. Table 9 is a summary of data from Table 8. It shows the number of foods at each site which would be expected to have relative standard errors of 0.1 or less, 0.1 to 0.2, and over 0.2. Figures are from a total of 12 foods at site A and a total of 24 foods at site B. Sample size 150 provides very poor estimates of total waste, especially at site B, where the relative standard error for only one food would be less than 0.1. Relative standard errors are greatly reduced with sample size 300. Even at sample size 300, however, there are three food items from site B with relative standard errors over 0.2 at population sizes 500 and 1000. The foods are turkey, soup, and cole slaw, all of which were selected and wasted by very few students on the day of testing.

The third way in which the accuracy of sampling was investigated involved the cost of the waste. Cost estimates were available for all 12 food items at site A and for 13 food items at site B. These costs were used to obtain the estimated total waste cost for each

*The formula used to estimate the standard error of the mean was $\sqrt{(1-n/N)s_Y^2/n}$. This standard error was divided by the mean to give the relative standard error.

Table 7. Standard Errors of the Mean Expressed in Grams for Three Population Sizes (N) and Two Sample Sizes

Site A	Sample Size = 300			Sample Size = 150		
Day 1:	N = 500	N = 1000	N = 2000	N = 500	N = 1000	N = 2000
Corned Beef	0.87	1.14	1.26	1.62	1.78	1.86
Bun	0.81	1.08	1.19	1.52	1.68	1.75
Cole Slaw	1.17	1.55	1.70	2.19	2.41	2.51
Banana	0.84	1.11	1.22	1.57	1.73	1.80
Milk	2.94	3.88	4.28	5.49	6.05	6.31
Mustard	0.07	0.10	0.11	0.14	0.15	0.16
Day 2:						
Chicken	0.62	0.82	0.90	1.16	1.27	1.33
Roll	0.52	0.69	0.76	0.97	1.07	1.12
Banana	1.03	1.36	1.50	1.93	2.12	2.22
Milk	3.02	3.99	4.40	5.64	6.22	6.49
Orange Juice	0.78	1.04	1.14	1.46	1.61	1.68
Ketchup	0.08	0.11	0.12	0.15	0.17	0.17

Table 7. Standard Errors of the Mean Expressed in Grams for Three Population Sizes (N) and Two Sample Sizes (Cont'd)

Site B	Sample Size = 300			Sample Size = 150		
Day 1:	N = 500	N = 1000	N = 2000	N = 500	N = 1000	N = 2000
Bacon	0.03	0.04	0.04	0.05	0.06	0.06
Macaroni & Cheese	2.25	2.98	3.28	4.21	4.64	4.84
Bread	0.40	0.53	0.58	0.75	0.83	0.86
Potato Chips	0.09	0.12	0.13	0.16	0.18	0.19
Green Beans	1.00	1.33	1.46	1.88	2.07	2.16
Green Pepper	0.04	0.06	0.06	0.08	0.09	0.09
Tomato	0.30	0.40	0.44	0.57	0.62	0.65
Onion	0.05	0.06	0.07	0.09	0.10	0.10
Lettuce with dressing	0.86	1.14	1.25	1.61	1.77	1.85
Jello	1.26	1.66	1.83	2.35	2.59	2.70
Cookies	0.57	0.76	0.84	1.07	1.18	1.23
Day 2:						
Hamburger	0.49	0.65	0.71	0.92	1.01	1.05
Turkey	0.26	0.35	0.38	0.49	0.54	0.56
Cheese	0.08	0.10	0.11	0.14	0.14	0.16
Bun	0.54	0.72	0.79	1.02	1.12	1.17
Bread	0.35	0.46	0.51	0.65	0.71	0.75
Gravy	0.22	0.29	0.32	0.42	0.46	0.48
Soup	0.52	0.69	0.76	0.97	1.07	1.12
Green Beans	0.75	0.99	1.09	1.40	1.54	1.61
Cole Slaw	0.48	0.63	0.70	0.89	0.98	11.03
Tossed Salad	0.78	1.03	1.14	1.46	1.61	1.67
Mixed Fruit	0.68	0.91	1.00	1.28	1.41	1.47
Fruit Drink	1.04	1.38	1.52	1.95	2.15	2.24
Cookies	0.22	0.30	0.33	0.42	0.46	0.48

Table 8. Standard Errors of the Mean Expressed as Proportions of the Mean for Three Population Sizes (N) and Two Sample Sizes

Site A	Sample Size = 300			Sample Size = 150		
Day 1:	N = 500	N = 1000	N = 2000	N = 500	N = 1000	N = 2000
Corned Beef	0.027	0.036	0.040	0.051	0.057	0.059
Bun	0.028	0.037	0.041	0.052	0.058	0.060
Cole Slaw	0.017	0.023	0.025	0.032	0.035	0.037
Banana	0.071	0.093	0.103	0.132	0.145	0.152
Milk	0.080	0.106	0.117	0.150	0.165	0.172
Mustard	0.034	0.045	0.050	0.064	0.070	0.073
Day 2:						
Chicken	0.037	0.049	0.054	0.070	0.077	0.080
Roll	0.053	0.070	0.077	0.099	0.109	0.114
Banana	0.059	0.078	0.086	0.110	0.122	0.127
Milk	0.083	0.110	0.122	0.156	0.172	0.179
Orange Juice	0.125	0.166	0.183	0.234	0.258	0.269
Ketchup	0.014	0.018	0.020	0.026	0.029	0.030

Table 8. Standard Errors of the Mean Expressed as Proportions of the Mean for Three Population Sizes (N) and Two Sample Sizes (cont'd)

Site B	Sample Size = 300			Sample Size = 150		
Day 1:	N = 500	N = 1000	N = 2000	N = 500	N = 1000	N = 2000
Bacon	0.109	0.144	0.159	0.204	0.224	0.234
Macaroni & Cheese	0.78	0.103	0.114	0.146	0.161	0.168
Bread	0.064	0.085	0.094	0.121	0.133	0.139
Potato Chips	0.141	0.187	0.206	0.264	0.291	0.304
Green Beans	0.068	0.089	0.098	0.126	0.139	0.145
Green Peppers	0.120	0.158	0.174	0.224	0.247	0.257
Tomato	0.107	0.141	0.156	0.200	0.220	0.230
Onion	0.088	0.116	0.128	0.165	0.181	0.189
Lettuce with dressing	0.074	0.98	0.108	0.138	0.152	0.159
Jello	0.079	0.105	0.116	0.148	0.164	0.171
Cookies	0.116	0.153	0.169	0.217	0.239	0.250
Day 2:						
Hamburger	0.070	0.093	0.103	0.132	0.145	0.152
Turkey	0.236	0.312	0.344	0.442	0.487	0.508
Cheese	0.138	0.182	0.200	0.257	0.283	0.296
Bun	0.063	0.083	0.091	0.117	0.129	0.135
Bread	0.147	0.195	0.215	0.276	0.304	0.317
Gravy	0.101	0.133	0.147	0.188	0.208	0.217
Soup	0.246	0.326	0.359	0.461	0.508	0.530
Green Beans	0.023	0.031	0.034	0.043	0.048	0.050
Cole Slaw	0.264	0.349		0.493	0.543	0.567
Tossed Salad	0.093	0.124	0.136	0.175	0.193	0.201
Mixed Fruit	0.102	0.135	0.149	0.191	0.210	0.220
Fruit Drink	0.150	0.198	0.218	0.280	0.308	0.322
Cookies	0.116	0.153	0.169	0.217	0.239	0.250

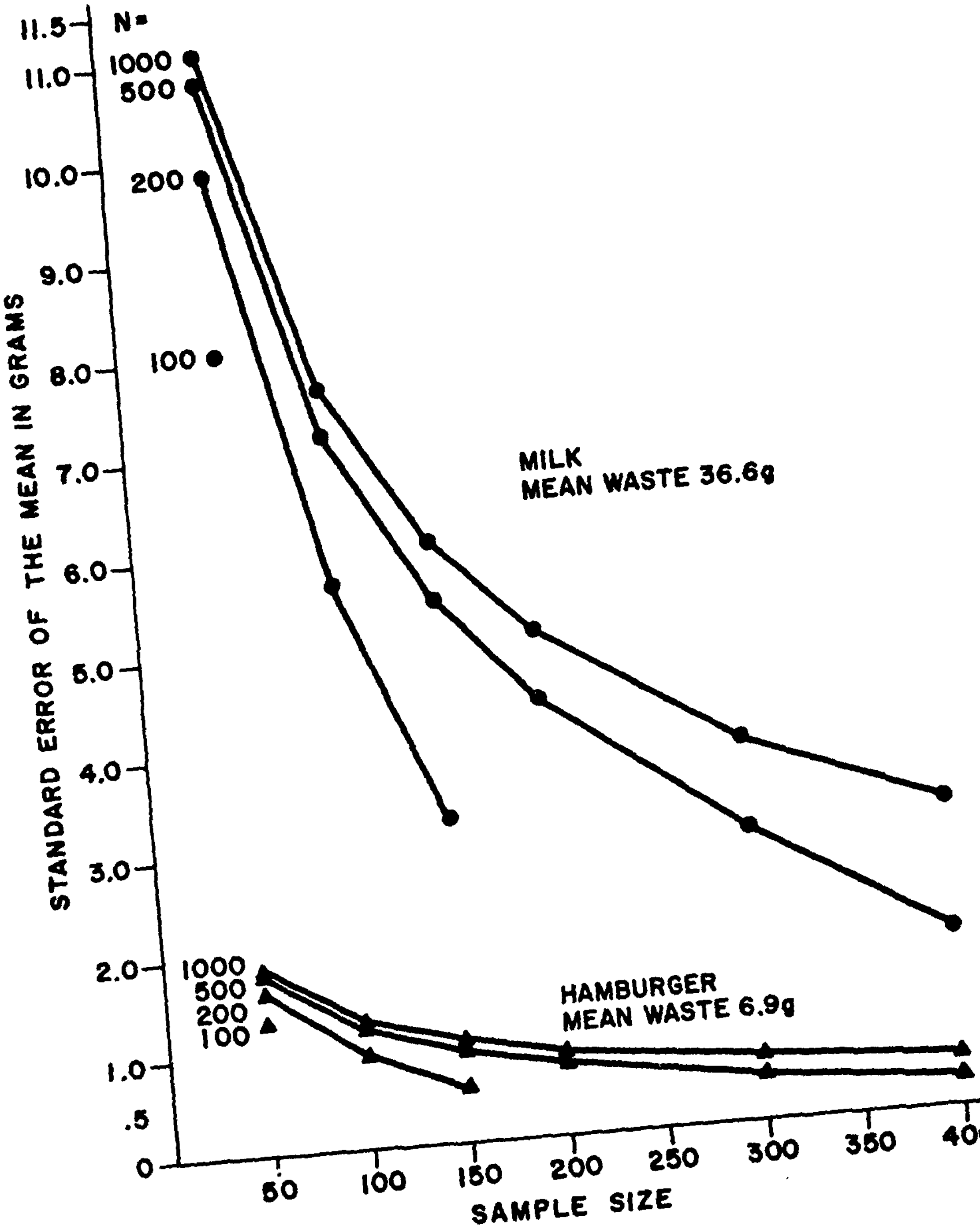

Figure 1. Standard Error of Mean Waste for Two Foods for Four Population Sizes (N) and Six Sample Sizes.

Table 9. Number of Foods and Relative Standard Errors for Three Population Sizes (N) and Two Sample Sizes

Relative Standard Error	Sample Size = 300			Sample Size = 150		
	N = 500	N = 1000	N = 2000	N = 500	N = 1000	N = 2000
Site A:						
0.1 or less	11	9	8	7	6	6
0.1 to 0.2	1	3	4	4	5	5
over 0.2	0	0	0	1	1	1
Site B:						
0.1 or less	10	6	4	1	1	1
0.1 to 0.2	11	15	13	11	9	8
over 0.2	3	3	7	12	14	15

food item and the standard errors of those totals in dollars. The estimated total costs and standard errors are shown in Table 10 for sample sizes 150 and 300 and for population sizes 500, 1000, and 2000.

Direct comparisons between site A and site B should not be made, since the costs obtained were not comparable. At site A, the cost information available was the cost of each serving, including preparation. At site B, the cost information available was for food items as initially purchased. In either case, it is apparent that the waste is generally not of negligible cost. For example, at site A, if 300 trays were sampled from a population of 1000 students, total corned beef waste would be estimated at $191.51, plus or minus a standard error of $6.92.

Aggregate selective plate waste

There were two major reasons for collecting aggregate selective plate waste. One was to begin to develop the sampling and scraping procedures. The recommendations of the NARADCOM research team for efficient procedures will be presented in Chapter 6.

The second purpose in collecting aggregate selective plate waste was to measure the amount of time required. Table 11 shows times for scraping five successive sets of ten trays on the second day at site B, when procedures were kept as close as possible to those expected to be employed in the final method. One researcher sampled trays and delivered them to a second researcher, who collected aggregate selective plate waste for thirteen separate food items.

The mean time for ten trays was 6 minutes and 37 seconds, which translates into approximately 40 seconds per tray or 91 trays per hour. This rate would be expected to be faster for menus with fewer food items or food items easier to separate. As a general guideline, a team of two reasearchers with experience would be expected to be able to selectively scrape close to 100 trays an hour. A team of three researchers might increase that rate to 150 or 200 trays an hour. Rates of aggregate selective plate waste collection were measured again during the final pretesting of the method.

CONCLUSION

The data collected in the summer feeding programs has led to the following general conclusions: First, plate waste in these programs was not of negligible cost. This finding is in agreement with studies of plate waste in school lunches and underscores the importance of analyzing the economic advantages of reducing plate waste.

Second, individual plate waste can be extremely variable, particularly when variability is measured relative to the mean or total waste. The higher the variability, the greater the number of trays that need to be sampled to reach a given criterion of accuracy in estimating total waste. In general, the foods which required the largest sample sizes were the foods of which the smallest percent was wasted and foods chosen least often.

Table 10. Estimated Cost in Dollars of Total Waste and Standard Error of That Total For Three Population Sizes and Two Samples Sizes (n)

Food Item Site A Day 1:	Population Size=500 Total $	n=150 Standard Error	n=300 Standard Error	Population Size=1000 Total $	n=150 Standard Error	n=300 Standard Error	Population Size=2000 Total $	n=150 Standard Error	n=300 Standard Error
Corned Beef	95.75	4.92	2.64	191.51	10.80	6.92	383.02	22.58	15.30
Bun	16.28	0.85	2.67	32.57	1.88	1.21	65.14	3.92	2.67
Cole Slaw	74.04	2.38	1.27	148.08	5.23	3.36	296.16	10.89	7.38
Banana	5.76	0.76	0.41	11.51	1.68	1.08	23.03	3.49	2.37
Milk	8.79	1.32	0.71	17.58	2.90	1.86	35.16	6.06	4.11
Mustard	2.11	0.13	0.07	4.22	0.35	0.19	8.45	0.70	0.42
Day 2:									
Chicken	34.63	2.42	1.29	69.26	5.30	3.42	138.53	11.09	7.51
Roll	8.79	0.87	0.47	17.58	1.92	1.24	35.16	4.01	2.72
Banana	7.51	0.83	0.44	15.02	1.82	1.17	30.05	3.82	2.58
Milk	8.68	1.35	0.72	17.36	2.99	1.92	34.71	6.23	4.22
Orange Juice	2.28	0.53	0.28	4.56	1.18	0.76	9.13	2.45	1.66
Ketchup	5.96	0.15	0.08	11.91	0.35	0.23	23.82	0.70	0.49

Table 10. Estimated Cost in Dollars of Total Waste and Standard Error of That Total For Three Population Sizes and Two Samples Sizes (n) (cont'd)

	Population Size=500			Population Size=1000			Population Size=2000		
Food Item Site B Day 1:	Total $	n=150 Standard Error	n=300 Standard Error	Total $	n=150 Standard Error	n=300 Standard Error	Total $	n=150 Standard Error	n=300 Standard Error
Bacon	0.35	0.07	0.04	0.70	0.16	0.11	1.40	0.32	0.22
Bread	2.58	0.31	0.17	5.15	0.69	0.44	10.31	1.43	0.96
Potato Chips	0.72	0.19	0.10	1.44	0.42	0.28	2.88	0.88	0.60
Green Beans	8.03	1.02	0.54	16.06	2.24	1.44	32.12	4.67	3.15
Tomato	1.29	0.26	0.14	2.58	0.56	0.35	5.15	1.18	0.80
Onion	0.15	0.03	0.01	0.30	0.06	0.03	0.59	0.11	0.08
Cookies	9.44	1.39	0.74	18.88	3.07	1.98	37.75	6.40	4.37
Day 2:									
Hamburger	9.82	1.30	0.69	19.64	2.86	1.84	39.28	5.94	4.02
Turkey	1.94	0.86	0.45	3.87	1.88	1.22	7.75	3.91	2.65
Cheese	0.91	0.23	0.13	1.82	0.53	0.33	3.64	1.06	0.73
Bun	3.60	0.42	0.22	7.20	0.93	0.60	14.39	1.94	1.31
Green Beans	17.53	0.75	0.41	35.07	1.66	1.07	70.14	3.48	3.25
Cookies	2.51	0.54	0.29	5.02	1.20	0.78	10.04	2.50	1.72

Table 11. Times Required To Collect Aggregate Selective Plate Waste

Set of Ten Trays	Time in Minutes and Seconds
1	8:25
2	5:40
3	6:00
4	7:21
5	5:45
Mean	6:37

Obviously, the more trays sampled in a lunchroom, the more accurate the estimates of total waste for each food item will be. In lunchroom populations of 300 students or less, it is recommended that all trays be scraped using aggregate selective plate waste procedures. In lunchroom populations of more than 300 students, it is recommended that trays be sampled to obtain a total of approximately 300 trays. These recommendations are based on the judgment that a team of three or four researchers can fairly easily scrape 300 trays during the one and a half or two hours of typical lunchroom operation. The pretests described in Chapter 5 further tested the time required for aggregate selective plate scraping. The second reason for recommending a sample size of 300 is that it appears to be a large enough sample to bring estimates of total waste of most food items to reasonable levels of accuracy. Errors in estimating waste will be expected for some food items, but these errors will tend to be largest for foods wasted the least and, thus, contributing least to the cost of the waste.

CHAPTER 5

PRETESTS OF THE AGGREGATE SELECTIVE PLATE WASTE METHOD

Methods for collecting aggregate selective plate waste were pretested in five schools between 12 September and 3 October 1979. The schools chosen for the pretests represented a broad cross section of types of kitchen and serving systems, school sizes, and ages of students. Table 12 lists several characteristics of the schools, which are also described in more detail below.

The pretests were designed to assure that the method would be usable in a broad range of school lunch settings, to improve its efficiency if necessary, and to test its validity. Validity was assessed by two means. First, two samples of aggregate selective plate waste were gathered in one school on a single day and compared. Second, individual plate waste was measured in two schools to assure that the measurements of variability, and thus the required sample sizes, in the summer programs (described in Chapter 4) were typical of school feeding situations in general.

Over the course of pretesting, the aggregate selective plate waste procedures were modified slightly to improve their overall efficiency. The final recommended procedures are described in Chapter 6, and the specific procedures used and data collected at each school are described below.

SCHOOL LUNCH PROGRAMS AND PRETESTING METHODS

Pretesting Methods

Procedures for collecting aggregate selective plate waste were kept as uniform as possible from school to school. Two or three members of the research team visited each school during a lunch period prior to the day of data collection in order to secure the cooperation of lunchroom personnel and to determine how to best implement the procedures with minimal disruption of normal lunchroom routines. Arrangements were made for the schools to provide tables near the tray return area to be used for holding trays and waste-collection equipment.

On the day of pretesting, the research team arrived approximately one hour prior to the beginning of the first lunch period. Menu items to be served that day were recorded and equipment was set up. To ensure that no plate waste was discarded by students before it could be sampled, trash containers normally distributed around the lunchroom were all gathered behind the tables where the research team worked. Empty weights were measured for all containers into which aggregate selective plate waste was to be scraped.

The research team always consisted of three or four people. One person was responsible for taking trays as they were brought to the waste disposal area, and for sampling trays when not every tray was to be scraped. Two people scraped for aggregate selective plate waste. One of the scrapers also counted stacks of trays which had been scraped before discarding them or turning them in to the dishroom to be washed. When a fourth person was on the

Table 12. Characteristics of School Lunch Programs Used in Pretesting

	School 1 Day 1	School 1 Day 2	School 2	School 3	School 4	School 5
Data Collection Date	9–12	9–26	9–14	9–19	9–21	10–3
Number of Students						
Approx. Total	435	435	570	228	560	1100*
Eating School Lunch	244	237	310	187	539	401*
Aggregate Sample	244	0	310	149	539	263
Individual Sample	0	100	0	38	0	0
Number of Foods Separated	21	20	19	7	6	22
Grade Range Served	1–6	1–6	7–9	1–5	1–5	9–12
Kitchen Type	off-site, bulk	off-site, bulk	on-site, bulk	off-site, pre-pack	on-site, bulk	on-site, bulk
Dishes Disposable?	no	no	no	yes	no	no
Dishes Compartmentalized?	yes	yes	no	yes	no	yes

*School 5 had two cafeterias, but only one was tested. Of approximately 1100 students, 878 were served school lunches. Of these, 401 were served lunches in the cafeteria tested.

research team, he or she helped the first researcher in handling the incoming trays, and removed paper and liquid waste before giving the trays to the scrapers.

The equipment and the procedures used for scraping and weighing aggregate selective plate waste are described in Chapter 6. Except for a few cases noted in the descriptions of schools below, containers used for collecting waste were number 10 cans and gallon-sized Ziploc bags. Milk, juice, and a few other food items were scraped directly into the number 10 cans. All other food items were scraped into Ziploc bags which had been inserted as liners into number 10 cans. When the Ziploc bags became fairly full they were removed from the number 10 cans, sealed, and set aside for weighing at the end of the meal. When the meal ended, the remaining Ziploc bags were closed, removed from the number 10 cans, and weighed along with those set aside earlier.

Individual plate waste was measured at two schools (School 1 on day 2 and School 3). The procedures and equipment were the same as those described in Chapter 4, except for occasional time-saving modifications described below for each school.

School 1

School 1 was a suburban elementary school which served lunch to approximately 240 students in grades one to six. Food was prepared in the kitchen of a neighboring junior high school (School 2) and delivered in bulk. Trays were nondisposable and compartmentalized. Students always had a choice of five entrees – the hot lunch or one of four sandwiches (submarine sandwich, peanut butter and jelly sandwich, peanut butter and marshmallow fluff sandwich, and a sandwich of the week, such as turkey). Milk was whole or skim, and juice was available in paper cups. Students sat at rectangular tables with attached stools. When they were finished eating, students typically returned their trays to one of two waste disposal areas, where they emptied milk and juice into a bucket and put trash and food waste into a large garbage container. There were three 30-minute shifts, and students were allowed to go outside to the playground after 15 minutes if they had finished eating.

On the first day at School 1, three researchers collected aggregate selective plate waste from all 244 students eating school-prepared lunches that day. An attempt was made to use procedures as close to the final recommended method as possible. The time required to scrape trays was measured from the time the first tray arrived at the waste disposal area to the time the last tray was scraped. The time required to weigh the aggregate selective waste was also measured.

Problems encountered at School 1 were as follows. First, an attempt was made to separate milk bought a la carte to drink with home lunches from milk bought with the school-prepared lunches. It was found to be too time-consuming and confusing to ask each student whether they had brought lunch from home. Since kitchens keep good counts of milks and lunches sold, it was decided that separating a la carte milk cartons was not necessary.

A second problem was that there was much more milk waste than the research team anticipated. We ran out of convenient containers to hold the waste. Weighing the milk waste was also a problem. The scale weighed a maximum of 1000 grams, and it could not be zeroed

with an object as heavy as a number ten can (about 285 grams) in place. Therefore, the research team was forced to weigh milk in portions smaller than 715 grams. Weighing would have been greatly speeded if a scale with a greater maximum weight had been available.

At School 1, the most troublesome menu item to separate was the submarine sandwich, which was separated into roll, lettuce, tomato, bologna, salami, and cheese. Separation could be done fairly accurately, but was time-consuming. Future researchers might want to consider leaving lettuce and tomato together, and all cold cuts together.

On the second day at School 1, three researchers collected individual plate waste only. Approximately every second tray was selected, for a total of 100 trays. One modification was made in the basic individual plate waste procedures. The 250 ml weigh boats used for individual plate waste measurements just barely held the contents of one milk carton; spills were frequent. Therefore, to save pouring and cleanup time, waste milk was weighed in the carton. Seven empty skim milk cartons and fifteen empty whole milk cartons were weighed and found to be very uniform. Skim milk cartons weighted 16 grams and whole milk cartons 13 grams. Carton weights were later subtracted as part of the data analysis.

School 2

School 2 was a junior high school in the same suburban community. Approximately 310 students in grades seven to nine were served lunch in three 45-minute shifts. Food was prepared in bulk on site and served on nondisposable, noncompartmentalized plates and trays. The menu choices were the same as at School 1. Students ate at rectangular tables for eight. When they were finished eating, they usually emptied milk and juice into a pail, put paper waste into a large container, and returned trays and plates to a single dishroom where food waste was removed.

Four researchers collected aggregate selective plate waste from all 310 students who brought school lunches. A la-carte milk waste from an additional 203 students was also collected. Time was measured from the arrival of the first tray to the scraping of the last tray. The portion of this time actually spent scraping was obtained by subtracting out the two periods of time at the ends of shifts one and two when researchers were idle waiting for the first trays from the next shifts to arrive. Time spent weighing the aggregates was also measured.

The biggest problem encountered at School 2 was a shortage of space for stacking trays prior to scraping. A majority of students tended to return their trays during a short period of time. The trays, with separate plates and dishes, were not easily stacked and required more handling in the process of collecting waste. A rack into which students or researchers could slide trays would have helped alleviate these problems.

The time-consuming food to separate at School 2 (as at School 1) was the submarine sandwich. Also, the tartar sauce was hard to scrape from the small paper cups in which it was served, because rubber spatulas did not fit inside the cups and some sauce tended to remain in the folds of the paper cup.

School 2 had a large volume of milk waste, but procedures were somewhat more efficient than at School 1. Milk cartons were set aside and not emptied until there was a lull in incoming trays. Enough containers were available, and weighings were done on a scale available in the school kitchen which could weigh up to 25 pounds.

School 3

School 3 was an urban elementary school. During three 40-minute shifts, 187 students in grades one to five were served prepackaged lunches in disposable containers. The hot pack contained the hot food, and the cold pack contained both the cold food in compartments of a small tray and the nonfood items such as napkin, straw, and utensils. The only menu choice was for milk (chocolate or whole), which was served in cartons. Students sat at rectangular tables with attached stools. Normally, as each student finished, waste was collected and discarded by lunchroom monitors. When all students from one classroom were finished eating, they returned to their classroom.

At School 3, three researchers collected individual plate waste from 38 trays and aggregate selective plate waste from the remaining 149 trays. The sample of trays for individual plate waste was obtained by putting every fifth tray on a separate table. Individual plate waste weighings were done when lulls occurred in the scraping for aggregate selective plate waste. Two people from the school system's food service program assisted researchers by collecting trays from students who had finished eating, and delivering these trays to the researcher who was sorting incoming trays. Since the individual plate waste measures and the extra helpers are not part of the recommended procedures, no time measurements were made at School 3.

One waste separation problem encountered was that the cheese in the cheeseburger was impossible to accurately separate from the bun. It was decided to weigh these items in one aggregate. Also, a second kind of juice was unexpectedly served in some of the lunches; both kinds of juice were collected in one aggregate. Since the procedure of not separating some food items might make it hard to determine costs of the waste, future researchers might want to attempt to separate these items, even though it may not be as accurate as other separations.

School 4

School 4 was another urban elementary school for students in grades one to five. Lunches were prepared in bulk on site and served on nondisposable trays and plates. Students could choose whole or chocolate milk, but choices were normally not offered on other major menu items. Approximately 539 students ate school lunches in three 40-minute shifts. Students sat at rectangular tables for eight. As students finished eating, trays were gathered by six lunchroom monitors, each responsible for four tables. Normally, the monitors dumped waste milk into a bucket and separately scraped food and nonfood waste from the plates before returning them to the dishroom. Students did homework at their tables until the lunch period ended.

At School 4, serving weights were obtained for all six food items on the menu. Six servings of pear halves and nine servings of spice cake were weighed prior to the meal. Serving

weights of pizza and mixed vegetables were obtained by having a researcher enter the serving line at a random point, collect a tray intended for a student, and weigh the served portions. Two trays were collected in this way during each of the three lunch shifts. Serving weights of milk were obtained by weighing the contents of five unopened whole milk cartons and eleven unopened chocolate milk cartons which had been returned as waste.

The purpose of collecting aggregate selective plate waste at School 4 was to partially validate the method. Two separate samples of aggregate selective plate waste were collected. Nine people (the six lunchroom monitors, two people from the school system's nutrition education program, and one researcher) collected trays from students who had finished eating, put all food waste onto the plate, and returned trays to the dishroom. Plates were delivered to a second researcher, who sorted plates into the two samples by alternately placing them on a table to the left or a table to the right. The third and fourth researchers selectively scraped separate samples, and counted and returned to the dishroom the plates they had completed. Milk cartons were not identified with the meals with which they had been served, but they were otherwise sorted into two samples by means of the same procedure used for plates. Weighings of the samples from the two scrapers were kept separate.

School 5

School 5 was a regional high school for students in grades nine to 12 in a mid-sized college town Lunches were prepared in bulk in an on-site kitchen and were served on nondisposable, compartmentalized trays. The kitchen served three 22-minute shifts in each of two separate cafeterias, one for 477 freshman and sophomores and one for 401 juniors and seniors. Each cafeteria had one serving line for the hot entree, a second serving line for fast foods including hamburgers, cheeseburgers, hot dogs, and submarine sandwiches, and a self-serve salad bar which included at least eight separate items plus dressings and condiments. Whole, chocolate, and coffee-flavored milk were available. Students ate at square tables for four. When finished eating, the students normally dumped paper waste into trash cans and returned their trays and utensils to the dishroom where food waste was scraped by kitchen workers.

Because the two cafeterias at School 5 were in different locations, it was not feasible to sample trays from both at the same time with the available research staff of four people. Therefore, aggregate selective plate waste was collected in only the junior-senior cafeteria. Kitchen workers indicated that approximately 450 to 500 students were expected to purchase lunch in the junior-senior cafeteria. In an attempt to sample about 300 trays, two out of every three trays were sampled, using the recommended sampling procedures described in Chapter 6. Actually, only 401 students were served, and only 263 trays were sampled. Total time required for scraping was measured from the time the first tray was brought to the waste disposal area until the time the last tray was scraped.

In two cases at School 5, exceptions were made in the general guidelines for waste separation. First, most salad bar components were not individually separated. Scraped together were lettuce, cucumber, tomato, onion, bacon bits, cottage cheese, and salad dressings. Second, cores, seeds, and peels were not separated from the fresh apples and oranges. These exceptions were made to save time, but depending on what price information is available, future researchers may want to separate these items.

AGGREGATE SELECTIVE PLATE WASTE RESULTS

Time Requirements

Time to scrape plates for aggregate selective plate waste was measured in three schools; time to weigh the aggregates was measured in two schools. As Table 13 shows, the times were fast and relatively uniform. Three or four researchers required under an hour and a half to scrape between 244 and 310 plates. On the average, this was 46 to 55 plates per hour per person. At each school, the research team was finished scraping for aggregate selective plate waste within 10 minutes of the end of the last lunch period.

Weighings required an average of just over half a minute each. The number of weighings required depended mostly on the number of food items separated, with occasional multiple weighings required for heavy food items which were wasted in large amounts. Thus, in a typical measurement situation, about 35 or fewer weighings would be expected, for a total time of 20 minutes or less. The high number of weighings (92) at School 1 occurred because of the high milk waste and the low maximum weight capacity of the scale.

In all the pretests, no major disruptions were caused in normal lunchroom routines, and no major delays were caused in normal dishroom or kitchen personnel schedules. School custodians usually waited 10 or 15 minutes to clean floors and empty trash containers while the last few weighings were being done.

In summary, a team of three or four researchers can expect to scrape approximately 300 plates for aggregate selective plate waste during the hour and a half or two hours of operation of a typical school lunchroom, plus 20 minutes or less for weighings and 30 minutes for preparation and clean-up activities.

In contrast with aggregate selective plate waste, individual plate waste requires substantially more time to collect. No precise measurements of time to collect individual plate waste were made as part of the pretests. However, the following observations were made. At School 1 on day 2, individual plate waste was measured for 100 trays. The research team of three people stopped at this number because of general fatigue after at least two hours and fifteen minutes, and because custodians had already been waiting at least a half hour to finish cleaning the floors.

In a related study by a member of the NARADCOM research team, two researchers collected individual plate waste using as rapid a procedure as possible. All food waste was weighed in individual serving containers, which had constant weights to be subtracted later. Even this rapid procedure required approximately two hours for between 100 and 125 trays. Any further speeding of the procedure would seem to require more scales and more researchers. Also, the rapid procedure is not applicable in the majority of lunchrooms, which do not serve food items in separate containers, and it also requires a much longer data transformation stage to subtract all the separate container weights.

Based on these observations, it can be concluded that aggregate selective plate waste measures allow data to be collected from at least two or three times as many trays as is possible with individual plate waste measures.

Table 13. Time Requirements of Aggregate Selective Plate Waste Collection During Pretesting[a]

	School		
	1	2	5
Number of Researchers	3	4[b]	4
Number of Trays Scraped	244	310	263
Total Minutes for Scraping	88	84[c]	86
Seconds per Tray	22	16	20
Trays per Hour per Person	55	55	46
Number of Weighings	92	31	–
Total Minutes for Weighing	49	16	--
Seconds per Weighing	32	31	–
Total Minutes Scraping and Weighing	137	100	–

[a]In addition to the times listed, approximately 30 minutes were spent in preparation and clean-up activities.

[b]Only three people were involved in weighing.

[c]Total busy time was 84 minutes, but an additional 27 minutes was spent waiting for trays to begin coming in from the two later shifts.

Amount of Waste

One product of the pretests was a set of data on amount of waste in the five schools visited. Since these data are not directly related to the usability and validity of the method, they are not discussed here, but are presented in the Appendix.

Comparison of Two Samples

As was described above, at School 4, two researchers each collected separate samples of aggregate selective plate waste. The samples were labeled left and right. To ensure that wasted food items from students at each table in each lunch shift were approximately equally represented in each sample, the sampling procedure was to sort every second plate and milk carton to each sample. The procedure resulted in a fairly accurate division, with only five more plates in the left sample than in the right sample. From the total of 539 plates and 542 cartons of milk served, left and right samples received 272 and 267 plates, and 271 and 271 cartons of milk, respectively.

Table 14 shows several characteristics of the waste collected for each of the six food items in the two samples and overall. The approximate percent waste for each food item, shown in the rightmost column, was calculated as follows. Numbers of servings of each food were determined by counting empty serving containers after the waste had been collected. There were 539 plates on which pizza, vegetables, and cake had been served, 57 whole and 485 chocolate milk cartons, and 404 paper cups in which pears had been served. The total waste in grams was divided by the number of servings. Then, dividing by the mean measured serving weight gave the approximate percent waste.

Also shown in Table 14 are the grams of waste collected for each food item in each sample. The figures for total grams waste are the sums of the grams of waste in the two samples. Notice that mixed vegetables was the food item most wasted, both in terms of grams waste (15873) and percent waste (80%). Approximately 17% of the whole white milk was wasted, but less than 10% of the other four food items was wasted.

The main reason for collecting two separate samples of aggregate selective plate waste was to check on the accuracy of estimating total waste from a sample. Projected total waste figures (in Table 14) were calculated from each sample for each food item. The method used was the one recommended in the aggregate selective plate waste method for estimating total waste when only the data from one sample are available; weight of waste in the sample was multiplied by the reciprocol of the proportion of plates or milk cartons in the sample. The accuracy of these projected totals was assessed by computing the percent error when compared with the obtained total waste.

In general, sample data provided good estimates of total waste. The three food items for which the estimated total waste differed by the smallest percentages from actual total waste were spice cake (1%), mixed vegetables (1.2%), and cheese pizza (8.4%). Somewhat worse percent errors were obtained for the remaining three food items, canned pear halves (14.5%), whole milk (15.8%), and chocolate milk (17.7%). Worse estimates were not unexpected for

Table 14. Comparison of Two Samples of Aggregate Selective Plate Waste at School 4

	Left Sample 272 Plates		Right Sample 267 Plates		Total 539 Plates		
	Grams Waste	Projected Total	Grams Waste	Projected Total	Grams Waste	Average Percent Error	Approximate Percent Waste
Food Item							
Cheese Pizza	1576	3123	1308	2640	2884	8.4	6
Mixed Vegetables	8105	16061	7768	15681	15873	1.2	80
Canned Pear Half	819	1623	600	1211	1419	14.5	6
Spice Cake	898	1779	899	1815	1797	1.0	8
Milk, Whole White*	1262	2524	918	1836	2180	15.8	17
Milk, Chocolate*	6202	12404	4336	8672	10538	17.7	9

*Milk cartons were not sampled with plates. The projected totals for milk are based on sample sizes of 271 cartons in each sample.

these three food items, because all three had low overall percent waste and high variability of individual plate waste. Milk waste was known to be difficult to estimate (see sections on individual plate waste variability in Chapter 4 and the following section). Informal observations while data were being collected at School 4 showed that waste of canned pear halves was also highly variable. Not all students received pears, and a great deal of trading of pear servings was observed.

In sum, the comparison of two separate samples supports the validity of the aggregate selective plate waste procedure. In a lunchroom serving 539 students, reasonably accurate estimates of total waste were obtained from samples of approximately half of the trays. As expected, food items for which estimates were worst all had high variability of individual plate waste and low overall waste. It should also be noted that in order to collect two samples of approximately equal size, fewer than 300 trays were sampled in each. Were the recommended 300 trays to be collected in a single sample, estimates of total waste would be expected to be even more accurate.

INDIVIDUAL PLATE WASTE VARIABILITY

Data on the variability of individual plate waste were collected at School 1 for 100 students and at School 3 for 38 students. The main reason for this comparison was to verify that plate waste variability obtained from the summer programs described in Chapter 4 is also representative of plate waste variability in actual school lunch programs. Menus differed widely between the summer programs and the school programs tested; therefore it is not appropriate to compare specific food items. Instead, general characteristics of amount and variability of plate waste will be compared.

Table 15 shows the mean waste in grams and the variance for each of the 26 food items measured at School 1 and at School 3. Comparable figures for the summer programs were presented in Table 5. Mean waste in the school programs ranged from 0.1 to 82.1 grams, as compared with a range of 0.3 to 68.2 grams in the summer programs. Variances in the school programs ranged from 1.1 to 8662.0 grams squared, as compared with a range of 0.6 to 6826.6 grams squared in the summer programs.

Of more relevance is the translation of these means and variances into required sample sizes, standard errors, and relative standard errors Table 15 shows the sample sizes required in a population of 500 for the standard error of the mean to be within 10% of the mean. Comparable figures for the summer programs were presented in Table 5. Required sample size was less than 300 for 16 of the 26 food items tested. The food items for which a larger sample size would be required were always food items with a very low amount of waste – apple sauce and components of sandwiches, which were chosen by very few students, potato chips, and liquids such as skim milk, fruit punch, and apple juice.

Table 15 also shows expected standard errors of the mean, expressed both in grams and as a proportion of the mean, if 300 trays were sampled from a population of 500. Comparable figures for the summer programs were presented in Table 7 and Table 8. The most important finding to notice here concerns the ten foods listed above which would require a sample size

Table 15. Means and Variances of Individual Plate Waste, Required Sample Sizes, and Standard Errors for Food Items at School 1 and School 3

Food Item	Mean Waste in Grams	Variance	Sample Size Required for N=500	Standard Errors of the Mean when N=500 and n=300	
				Grams[b]	Proportion
School 1:					
Spaghetti	24.1	1479.5	169	1.40	0.058
Carrots	11.3	179.8	111	0.49	0.043
Roll & Butter	5.3	94.3	202	0.35	0.067
Sandwich 1, Bread	0.9	21.7	423	0.17	0.191
Ham	0.2	1.1	435	0.04	0.211
Cheese	0.3	4.4	451	0.08	0.248
Peanut Butter & Jelly Sandwich	1.2	65.3	452	0.30	0.250
Peanut Butter & Fluff Sandwich	1.1	26.9	413	0.19	0.177
Sub Sandwich, Roll	6.9	244.7	253	0.57	0.083
Chopped Salad	3.6	55.7	229	0.27	0.075
Cheese	2.2	30.8	278	0.20	0.091
Ham	3.3	54.1	253	0.27	0.083
Bologna	2.8	42.3	262	0.24	0.086
Cake	6.4	179.7	232	0.49	0.076
Apple Sauce	0.1	1.2	461	0.04	0.280
Pickles	1.6	15.0	264	0.14	0.086
Potato Chips	1.0	11.5	347	0.12	0.123
Milk, Whole	82.1	8662.0	103	3.40	0.041
Milk, Skim	22.4	4050.1	310	2.32	0.104
Fruit Punch	3.6	195.8	374	0.51	0.140
School 3:					
Hamburger	9.6	312.7	204	0.65	0.068
Bun & Cheese	15.1	478.7	149	0.80	0.053
Peaches	31.2	1289.9	105	1.31	0.042
Apple Juice	4.1	205.9	355	0.52	0.128
Milk, Whole[a]	70.0	6172.0	101	2.87	0.041
Milk, Chocolate[a]	41.8	5099.7	211	2.61	0.063

[a]Chocolate and whole milk calculations were based only on the numbers of cartons of each flavor of milk served.

[b]Standard errors of the **total** waste can be obtained by multiplying standard errors of the mean in grams by 300.

of over 300. When only 300 trays are sampled, standard errors exceed 10% of the mean. For six of the ten foods, the standard errors are less than 20% of the mean, and in no case does the standard error exceed 28% of the mean. Since these ten foods all had very low mean waste in grams, the higher proportion standard error corresponds to a very low standard error in grams.

To summarize, data on individual plate waste variability in school lunches necessitate no changes in the conclusions drawn on the basis of data from the summer programs. In Table 16, the two sets of data are combined and summarized on several characteristics, assuming a population size of 500 trays. Site A and School 3 had menus with no choice, served prepackaged. Of the 18 food items served, 16 required sample sizes of less than 300 for the standard errors to be within 10% of the mean. More variability of waste was observed at Site B and School 1, which offered a choice among more food items, served in bulk. Of the 44 food items measured, 22 required sample sizes of less than 300. Table 16 also shows that the ranges of sample sizes required and standard errors are similar for summer programs and school programs. Required sample sizes and standard errors expressed as proportions tend to have higher upper values in programs which offered menu choices, served in bulk.

CONCLUSION

In general, pretests of the aggregate selective plate waste method showed it to be usable in a broad range of school lunch settings, including prepackaged and bulk service, small and large lunchroom populations, and students in grades 1 through 12. Over the course of pretesting, procedures were modified slightly to improve their efficiency. The recommended procedures for measuring aggregate selective plate waste are presented in Chapter 6.

Aggregate selective plate waste measurement was found to be much faster than individual plate waste measurement. A team of three or four researchers can expect to collect waste from 300 plates during the hour and a half or two hours of typical lunchroom operation. An additional 30 to 50 minutes may be required for preparation, weighing, and clean-up activities.

In lunchrooms serving more than 300 students, it is recommended that approximately 300 plates be sampled. Measures of individual plate waste and the comparison of two separate samples of aggregate selective plate waste showed that 300 plates will provide an acceptable level of accuracy in estimating waste in larger lunchroom populations.

Table 16. Characteristics of Food Waste in Lunchroom Populations of 500

School	Number of Food Items	Number of Food Items With Required N = 300	Range of Required N	Ranges of Standard Errors when N=300: Grams	Ranges of Standard Errors when N=300: Proportion
Menus with no choice, served prepackaged:					
Site A, Day 1	6	6	22 – 246	0.07 – 2.94	0.027 – 0.080
Site A, Day 2	6	5	14 – 351	0.08 – 3.02	0.014 – 0.125
School 3[1]	6	5	101 – 355	0.52 – 2.87	0.041 – 0.128
Menus with choice, served in bulk:					
Site B, Day 1	11	7	193 – 375	0.03 – 2.25	0.064 – 0.120
Site B, Day 2	13	4	37 – 457	0.08 – 1.04	0.023 – 0.264
School 1	20	11	103 – 461	0.04 – 3.40	0.041 – 0.280

[1]Chocolate and whole white milk calculations were based only on the number of cartons of each flavor of milk served.

CHAPTER 6

RECOMMENDED PROCEDURES FOR MEASURING AGGREGATE SELECTIVE PLATE WASTE

The procedures described here are to be used in studies of plate waste in school lunchrooms. They have been designed to provide information as accurate as practicable on the absolute weight or cost of the waste of specific food items. Aggregate selective plate waste is appropriate to use in answering questions such as the following.

- How much of a specific food item is wasted?
- How much does student plate waste cost?
- What percent of food is wasted? (In this case, in addition to weighing plate waste, food must be weighed before serving.)
- When large numbers of schools are compared, what factors influence the amount of plate waste (e.g., type of serving system, age range of students, number of menu choices, etc.)?

For some questions involving amount of waste, individual plate waste measures are more appropriate than aggregate plate waste measures. For example, individual plate waste should be used if a school wishes to compare waste for two methods of food preparation, for different age groups within the school, or before and after a nutrition education project. Guidelines for measuring individual plate waste have been published by USDA (1975(b)).[86] The guidelines for measuring aggregate selective plate waste presented here follow the same general outline, with necessary modifications in the details of the procedures.

STAFF

The procedures for aggregate selective plate waste measurement require at least two people. Three or four people greatly speed the process and may be essential in schools where the volume of trays being returned at one time is high. In occasional schools with more than one tray return area, even more people may be required. Typical divisions of duties during the actual collection and scraping of trays are as follows.

Two People: Person A samples and delivers trays to be scraped, counting and returning completed trays to the dishroom as time permits.
Person B scrapes and separates plate waste.

[86] USDA/FNS. General guidelines for determining food acceptability, 1975(b).

Three People: Person A samples and delivers trays to be scraped.
Person B scrapes and separates plate waste.
Person C helps scrape plates, and counts and returns completed trays to the dishroom.

Four People: Person A samples trays to be scraped.
Person B delivers trays to be scraped and removes paper and liquid waste.
Person C scrapes and separates plate waste.
Person D helps scrape plates, and counts and returns completed trays to the dishroom.

Notice that it is recommended that trays not be counted until after they have been scraped. This procedure reduces the burden on Person A, who needs to devote full attention to receiving incoming trays.

EQUIPMENT

The following equipment is recommended. It should be assembled and set up well before the start of the meal for which waste is to be measured.

1. **Tables and racks near the tray return area**

   - Tables must be large enough to hold all the containers for food item waste in positions convenient for scraping.

   - Tables must also be large enough to hold many trays waiting to be scraped and trays waiting to be returned to the dishroom.

   - If space for tables is limited, racks to hold trays waiting to be scraped are also useful.

2. **Containers into which to scrape waste**

   Number ten cans with Ziploc bags (gallon size) as liners work well.

   - At least one container is required for each food item to be separated, but many items will require more than one container. Bring plenty of [illegible].

   - The empty weight of each container should be measured [illegible] prior to the meal.

3. **Scales for weighing the aggregate selective plate waste**

   - Ideal scales measure to the nearest gram with a capacity of 5000 grams.

4. **Rubber spatulas**

   - Bring at least one for each person who will be scraping.

5. Aprons or lab coats for all people involved in collecting data

6. Forms (see Figure 2), pencils, and clipboard for data recording

7. Paper towels and sponges for clean-up

SAMPLING PROCEDURES

In order to obtain an accurate weight of food waste, it is recommended that the waste from approximately 300 trays be weighed. In schools with 300 or fewer students eating the school-prepared meal, all trays should be collected for weighing. In schools with more than 300 students, a large enough proportion of the trays should be collected to ensure that a sample of at least 300 trays is collected for weighing.

It is important to use a procedure for collecting trays which gives every tray an equal chance of being in the sample. Sampling procedures should be determined by the following three steps.

1. **Determine the number of students expected to be served.**

   The food service director or the lunchroom cashier can usually provide this information.

2. **Determine the sampling ratio.**

   a. If the number of students is 300 or fewer, the sampling ratio is 1. All trays should be collected for weighing.

   b. If the number of students is over 300, the sampling ratio should be determined by one of the following two methods.

   Method 1 – Consult Table 17

   In the first column, locate the range which includes the number of students you expect to be served. Read across to the recommended sampling ratio in the second column. For example, if 850 students were to be served, 3/8 of the trays should be collected for weighing.

   Method 2 – Compute directly

   Divide 300 by the number of students expected to be served. Round up to the nearest simple fraction which ensures a sample size of 300. For example, 300 divided by 850 expected students is 0.353. This can be rounded up to 3/8 (0.375).

School: Town: Date
Number of trays sampled ______ Sampling procedure:
Number of trays served ______

Food Item	Description of Preparation	Cost	Container Weight Full	Container Weight Empty	Waste Weight
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					

Figure 2

Sample Form for Recording
Aggregate Selective Plate Waste Data

Table 17. Recommended Sampling Ratios for Different Lunchroom Sizes

Number of Students Expected to be Served	Recommended Sampling Ratio	Number of Trays Sampled
350 or fewer	1/1	– 350
350 –399	6/7	300 – 342
400 – 449	3/4	300 -- 337
450 -- 499	2/3	300 -- 333
500 – 599	3/5	300 – 359
600 – 699	1/2	300 – 350
700 – 799	3/7	300 –342
800 – 899	3/8	300 – 337
900 – 1199	1/3	300 – 400
1200 – 1499	1/4	300 – 375
1500 -- 1799	1/5	300 – 360
1800 – 2099	1/6	300 – 350
2100 – 2399	1/7	300 – 343
2400 – 2699	1/8	300 – 337
2700 – 2999	1/9	300 – 333
3000 – 3299	1/10	300 – 330

c. The sampling ratio determines a sampling cycle, which should be used as follows to select trays for weighing. The numerator indicates the number of trays to be sampled in a row, and the denominator indicates the total number of trays in the cycle to count before sampling again. For example, if the sampling ratio is 3/8, 3 trays should be sampled from every 8, or 3 sampled, 5 not sampled, 3 sampled, 5 not sampled, etc. This sampling cycle may be schematically illustrated SSSNNNNN.

3. **Determine the starting position in the sampling cycle.**

Use a table of random numbers to select a number between 1 and the denominator of the sampling ratio. This random number indicates the starting position in the sampling cycle. When the first tray is returned to the dishroom by a student, the sampling cycle should be initiated at the starting position. For example, if the sampling ratio is 3/8, a random number should be found between 1 and 8. Suppose the random number is 5. Then the starting position is the 5th position in the sampling cycle, shown underlined in this schematic illustration: SSSN<u>N</u>NNN. The first tray returned to the dishroom would be the 5th tray in the cycle and should not be sampled. The next 3 trays should also not be sampled, then the cycle should restart with 3 trays sampled. Once the sampling procedure has been determined, it should be recorded on a form such as the one shown in Figure 2.

SCRAPING AND WEIGHING PROCEDURES

Before the start of the meal, researchers must determine which foods will be collected and weighed separately. A detailed menu should be obtained from the kitchen supervisor. Items such as condiments, different components of composite foods, and milk choices should all be listed separately on a form such as the one illustrated on Figure 2. Since different components of a menu item may cost different amounts, it is important to separate as many components as can be done accurately without excessive labor. The following are examples of recommended separation procedures.

1. **DO separate**

- Hot dogs from buns
- Sandwich fillings from bread (when not too much filling soaks into the bread)
- Green beans from mashed potatoes, where these were served as separate menu items

2. **PARTIALLY separate**

- Submarine sandwiches into major components, such as roll plus butter, chopped mixed salad items, cheese, cold cuts

3. **DO NOT separate components of**

- Spaghetti and sauce
- Casseroles
- Pizza
- Sandwiches in which the filling is very hard to separate accurately from the bread, such as peanut butter and jelly, grilled cheese
- Foods with sauces or condiments mixed or soaked in, such as buttered bread, dressing on salad, meat and gravy
- Soups
- Frosting and cake
- Mixed vegetables, where they are served as one menu item
- Vegetables and fruits with their juices
- Tossed salad components

Once the separation procedures have been determined, the number of containers required to collect the waste should be placed on the waste-collection tables. As student trays in the sample are returned to the dishroom, all edible food waste should be scraped from the trays and dishes.

- Discard nonfood items such as straws, napkins, and utensils.
- Use a rubber spatula to scrape plates thoroughly.
- Empty all individually packaged foods, such as milk, condiments, and potato chips.

Ideally, only the portion of any food item that is normally considered edible should be weighed. Inedible food waste should not be included in the weight of the waste.

1. **Items to be weighed**

The following components are usually considered edible, even though some students may not [illegible] them. They should be weighed with the accompanying food item.

- Fruit peels from apples, grapes, peaches, and pears
- Fruit cores from apples and pears

- Granishes such as pickles, bacon bits, pimento
- Skins from chicken and turkey
- Meat fat
- Gravies, sauces, cooking liquids
- Bread crusts

2. **Items NOT to be weighed**

   The following items are not usually considered edible. Whenever possible, they should be separated and discarded before the accompanying food item is weighed.

   - Bones
   - Fruit peels and skins from bananas, oranges, and grapefruit
   - Pits, seeds, and stems

3. **Items to be estimated and subtracted from total weight**

   Some inedible food portions may require too much time to accurately separate from the edible portions. Items for which this is likely include chicken bones and some fruit pits, peels, and seeds. If the researchers judge that this is the case, the weight of the inedible portion may be estimated as follows.

   a. Obtain a count of the number of portions of the food item served. For example, suppose 200 students were served chicken.

   b. Separate and weigh the inedible parts of a sample of these servings. For example, randomly collect 10 or more trays throughout the lunch period and carefully cut the chicken off the bones.

   c. Estimate the total weight of the inedible portions by calculating the mean weight of the inedible portions and multiplying by the total number of servings. For example, if 10 servings of chicken had bone weights totalling 300 grams, mean bone weight would be 30 grams. Estimated total bone weight for 200 students would be 6000 grams.

   d. Chicken waste from the lunchroom should then be weighed **with** bones and the estimated bone weight subtracted.

When the meal is completed and all the sampled trays have been selectively scraped, the aggregate selective plate waste should be weighed in the containers and recorded on a form such as the one shown in Figure 2. Container weights should then be subtracted to calculate net weight of plate waste for each food item.

ADDITIONAL IMPLEMENTATION RECOMMENDATIONS

The general procedures for measuring aggregate selective plate waste have been described above. In addition, there are three specific recommendations which will help ensure that measures of plate waste are as accurate as possible.

First, researchers should consider collecting milk and juice waste from all trays, even when only a sample of trays is used for other food items. The reason for this recommendation is that waste from milk and other liquids such as juice has consistently shown high variability, and therefore requires large sample sizes to estimate accurately. Since milk and juice are served in separate containers, it should be relatively easy to remove them from trays, regardless of whether other food items are to be sampled or not.

Second, 300 trays should not be considered a ceiling; researchers should scrape as many trays as possible. If a team of researchers can scrape more rapidly than the estimates presented in this report suggest, then more trays should be scraped.

Third, the set of schools in which aggregate selective plate waste is measured should probably be chosen to include a somewhat disproportionately large number of large schools with many menu choices. The rationale for this recommendation is as follows. The overall goal is to measure plate waste in national school lunch and school breakfast programs in different types of schools across the country. To obtain measures of plate waste as accurate as possible for each type of school, more schools need to be sampled the more variable the measures are expected to be. Measures of plate waste will tend to be more variable in larger schools with more menu choices, and therefore more such schools should be included in the national sample.

This document reports research undertaken at the US Army Natick Research and Development Command and has been assigned No. NATICK/TR-81/011 in the series of reports approved for publication.

REFERENCES

Acredolo, L.P. and H.L. Pick. Evaluation of a school lunch program. **Psychological Reports,** 1975, **37**, 331–332.

Altschul, A.M. Studies in school lunch waste – A literature review and evaluation. USDA/FNS Contract 557–FNS–76, 1976.

Augustine, G., M. McKinley, S.L. Laughlin, E.L. James and E. Eppright. Nutritional adequacy, cost and acceptability of lunches in an Iowa school lunch program. **Journal of the American Dietetic Association**, 1950, **26**, 654–662.

Bell, C.G. and M.W. Lamb. Nutrition education and dietary behavior of fifth graders. **Journal of Nutrition Education**, 1973, **5**, 196–199.

Brine, C.L. and E.B. Tate. Effect of food losses on nutritive content of diets in four institutions. **Journal of the American Dietetic Association**, 1956, **32**, 19–23.

Bryan, M.S. and M.E. Lowenberg. The father's influence on young children's food preferences. **Journal of the American Dietetic Association**, 1958, **34**, 30–35.

Carver, A.F. and M.B. Patton. Plate waste in a school lunch, I. Overall waste. **Journal of the American Dietetic Association**, 1958, **34**, 615–618.

Chmielinski, H.E. and M.A. White. Plate Waste Index: An observational measure of school food waste. Teachers College, Columbia University, 1978.

Cochran, W.G. Sampling Techniques. New York: Wiley, 1953.

Determining what's going down or out. **School Foodservice Journal**, 1976, **30** (Sept), 65–70.

Ellis, B.H. Preference testing methodology. **Food Technology**, 1968, **32** (May), 49–56.

Food preference surveys help cut plate waste. **School Foodservice Journal**, 1978, **32** (Sept.), 21.

Guthrie, H.A. Effect of a flavored milk option in a school lunch program. **Journal of the American Dietetic Association**, 1977, **71**, 25–30.

Hageman, M.I. A study of plate waste as a directive measure in food conservation: Part I. **Journal of the American Dietetic Association**, 1945, **21**, 608–610.

Hageman, M.I. A study of plate waste as a directive measure in food conservation: Part II. **Journal of the American Dietetic Association**, 1945, **21**, 685–689.

Harper, J.M. and G.R. Jansen. Phase II Report; Comparison of Type A and NSM menus in the National School Lunch Program. USDA/FNS Contract 12–35–600–85, 1973.

Harrison, G.G., W.L. Rathje and W.W. Hughes. Food waste behavior in an urban population. **Journal of Nutrition Education**, 1975, 7(1), 13–16.

Head, M.K., F.G. Giesbrecht and G.N. Johnson. Food acceptability research: Comparative utility of three types of data from school children. **Journal of Food Science**, 1977, **42**, 246–251.

Head, M.K. and R.J. Weeks. Conventional vs. formulated foods in school lunches. II. Cost of food served, eaten and wasted. **Journal of the American Dietetic Association**, 1977b, 71, 629–632.

Head, M.K. and R.J. Weeks. Major nutrients in the Type A lunch. II. Amounts consumed by students. **Journal of the American Dietetic Association**, 1975, **67**, 356–360.

Hunt, F.E., M.B. Patton and A.F. Carver. Plate waste in a school lunch III. Vegetable acceptance study. **Journal of the American Dietetic Association**, 1958, **34**, 810–813.

Ireton, C.L. and H.A. Guthrie. Modification of vegetable-eating behavior in preschool children. **Journal of Nutrition Education**, 1972, **4**, 100–103.

Jansen, G.R. and J.M. Harper. Consumption and plate waste of menu items served in the National School Lunch Program. **Journal of the American Dietetic Association**, 1978, **73**, 395–400.

Jansen, G.R., J.M. Harper, A.L. Frey, R.H. Crews, C.T. Shigetomi and J.B. Lough. Comparison of Type A and nutrient standard menus for school lunch. III. Nutritive content of menus and acceptability. **Journal of the American Dietetic Association**, 1975, **66**, 254–261.

Jones, L.V., D.R. Peryam and L.L. Thurstone. Development of a scale for measuring soldiers' food preferences. **Food Research**, 1955, **20**, 512–520.

Kish, L. Survey Sampling. New York: Wiley, 1965.

LaChance, P.A. Simple research techniques for school foodservice. Part I: Acceptance testing. **School Foodservice Journal**, 1976, **30** (Sept), 54–61.

LaChance, P.A. Simple research techniques for school foodservice. Part II: Measuring plate waste. **School Foodservice Journal**, 1976, **30** (Oct), 67–76.

Lamb, M.W. and B. Ling. An analysis of food consumption and preferences of nursery school children. **Child Development**, 1946, **17**, 187–217.

Litman, T.J., J.P. Cooney, Jr. and R. Stief. The views for Minnesota school children on food. **Journal of the American Dietetic Association**, 1964, **45**, 433–440.

Marshall, M.M. An inquiry into the food attitudes characteristics of the children in the Menands school. M.S. Thesis, University of Massachusetts, 1956.

Meiselman, H.L., W. Van Horne, B. Hazenzahl and T. Wehrly. **The 1971 Fort Lewis Food Preference Survey**. NARADCOM Technical Report, TR–72–43–PR, 1971.

Meredith, A., A. Matthews, M. Zickefoose, E. Weagley, M. Wayave and E.G. Brown. How well do school children recall what they have eaten? **Journal of the American Dietetic Association**, 1951, **27**, 749–751.

Mirone, L. and L.G. Harvey. A new menu pattern is tested. **Journal of the American Dietetic Association**, 1954, **30**, 757–761.

O'Connor, M.A. Preference maximized school lunch menu planning. M.S. Thesis, University of Massachusetts, 1975.

Patton, M.B., A.F. Carver and F.E. Hunt. Plate waste in a school lunch. II. Sources of waste. **Journal of the American Dietetic Association**, 1958, **34**, 733–737.

Peryam, D.R. and F.J. Pilgrim. Hedonic scale method of measuring food preferences. **Food Technology**, 1957, **11**, 9–14 (following page 472).

Pilgrim, F.J. What foods do people accept or reject? **Journal of the American Dietetic Association**, 1961, **38**, 439–443.

Rathje, W.L. and G.G. Harrison. Monitoring trends in food utilization: application of an archeological method. **Federation Proceedings**, 1978, **37**(1), 50–54.

Robinson, J.S. Special milk program evaluation and National School Lunch Program survey. USDA/FNS: 1978, 52–57.

Sando, L.G. and M.B. Patton. Lunch programs in Ohio Public Schools. **Journal of the American Dietetic Association**, 1951, **27**, 285–288.

Schorr, B.C., D. Sanjur and E.C. Erickson. Teen-age food habits. **Journal of the American Dietetic Association**, 1972, **61**(4), 415–420.

Schuh, D.D., A.N. Moore and B.H. Tuthill. Measuring food acceptability by frequency ratings. **Journal of the American Dietetic Association**, 1967, **51**, 340–343.

Smutz, E.R., H.L. Jacobs, D. Waterman and M. Caldwell. Small sample studies of food habits: I. The relationship between food preference and food choice in naval enlisted personnel at the Naval Construction Battalion Center, Davisville, RI, Natick, MA: NARADCOM, 1974, Technical Report 75–52–FSL.

Sullins, W.R., L.E. Symington, J.R. Siebold and J.G. Rogers. Food preference, acceptance, *and consumption in a simulated*, isolated-duty station. Natick, MA, NARADCOM, 1977. Technical Report Natick/TR–78/027.

USDA/FNS. Comparison of Type A and Computer assisted nutrient standard menus. Date County Public Schools. Contract No. 12–35–600–116, 1975.

USDA/FNS. General guidelines for determining food acceptability. 1975.

USDA/FNS. Comparison of Type A and Nutrient Standard Menus. Memphis City Schools. Contract No. 12–35–600–115, 1975.

USDA/FNS. Pilot study to assess, audit, and evaluate food delivery systems used in school food service. Contract No. 12–35–600–183, 1976.

USDA/FNS. Food consumption in the National School Lunch Program. 1978a.

USDA/FNS. Pilot study to compare Type A lunches with alternative subsidized lunches among high school students. Contract No. 12–35–600–351, 1978b.

Waterman, D., H. Meiselman, T. Reed, L. Symington and L. Branch. Food Preferences of Air Force enlisted personnel. NARADCOM Technical Report 75–51–FSL, Natick, 1974.

What's wrong with school lunch. **School Lunch Journal**, 1971, May 1971, 42–51.

Young, C.M., F.W. Chalmers, H.N. Church, M.M. Clayton, G.C. Murphy and R.E. Tucker. Subjects estimation of food intake and calculated nutritive value of the diet. **Journal of the American Dietetic Association**, 1953, 29, 1216–1220.

Young, C.M. and T.D. LaFortune. Effect of food preferences on nutrient intake. **Journal of the American Dietetic Association**, 1957, **33**, 98–103.

BIBLIOGRAPHY

Abramson, J.A., C. Slome and C. Kosovsky. Food frequency interview as an epidemological food. **American Journal of Public Health**, 1963, **7**, 1093–1101.

Acheson, K.J., I.T. Campbell, O.G. Edholm, D.S. Miller and M.J. Stock. The measurement of food and energy intake in man – an evaluation of some techniques. **American Journal of Clinical Nutrition**, 1979, (In press).

Beal, V.A. Nutritional intake of children, I. Calories, carbohydrate, fat and protein. **Journal of Nutrition**, 1953, **50**, 223–234.

Bender, A.E., P. Magee and A.H. Nash. Survey of school meals. **British Medical Journal**, 1972, **2**, 383–385.

Beyer, N.R. The food habits and nutrient intake of elementary school children: a longitudinal approach. M.S. Thesis, Michigan State University, 1972.

Beyer, N.R. and P.M. Morris. Food attitudes and snacking patterns of young children. **Journal of Nutrition Education**, 1976, **6**, 131–133.

Bosley, B. A practical approach to nutrition education for children. **Journal of the American Dietetic Association**, 1947, **23**, 304–309.

Boysen, S.C. and R.A. Ahrens. Nutrition instruction and lunch surveys with second graders. **Journal of Nutrition Education**, 1972, **4**, 172–175.

Breckenridge, M.E. Food attitudes of five-to-twelve-year-old children. **Journal of the American Dietetic Association**, 1959, **35**, 704–709.

Burk, M.C. and E.M. Pao. Methodology for large-scale surveys of household and individual diets. Home Economics Report Number 40, DC:USGPO, 1976.

Burke, B.S. The dietary history as a tool in research. **Journal of the American Dietetic Association**, 1947, **23**, 1041–1046.

Chalmers, F.W., M.M. Clayton, L.W. Gates, R.E. Tucker, A.W. Wertz, C.M. Young and W.D. Foster. The dietary record – how many and which days. **Journal of the American Dietetic Association**, 1952, **28**, 711–717.

Christakis, G., A. Miridjanian, L. Nath, H.S. Khurana, C. Cowell, M. Archer, O. Frank, H. Ziffer, H. Beher and G. James. A nutritional epidemiological investigation of 642 New York City Children. **American Journal of Clinical Nutrition**, 1968, **21**, 107–126.

D'Arezzo, P.M. Person-to-person. **Food and Nutrition**, 1975, **5**, 10–13.

Emmons, L. and M. Hayes. Accuracy of 24 hour recalls of young children. **Journal of the American Dietetic Association**, 1973, **62**, 409–414.

Emmons, L., M. Hayes and D.L. Call. The Lunch Bunch study. **School Foodservice Journal**, 1972, **26** (Sept.), 25--29.

Emmons, L., M. Hayes and D.L. Call. Summary and conclusions from the final report of a study to determine the nutritional and economic need for free lunches and to measure the effect of receiving school breakfasts and/or lunches on the nutritional status of children. The Lunch Bunch study. Photocopy, 1972.

Eppright, E.S., M.B. Patton, A.L. Marlatt and M.L. Hathaway. Dietary study methods, V. Some problems in collecting dietary information about groups of children. **Journal of the American Dietetic Association**, 1952, **28**, 43–48.

Eppright, E.S. and P.P. Swansen. Distribution of nutrients among meals and snacks of Iowa school children. **Journal of the American Dietetic Association**, 1955, **31**, 256–260.

Eppright, E.S. **et al**. Nutrition of 9-, 10-, and 11-year-old public school children in Iowa, Kansas and Ohio. I. Dietary Findings. **Iowa Agricultural Experimental Station Research Bulletin 434**, North Central Regional Publication No. 59, 1955, 613–631.

Gersovitz, M., J.P. Madden and H.S. Wright. Validity of the 24-hour dietary recall and seven-day record for group comparisons. **Journal of the American Dietetic Association**, 1978, **73**, 48–55.

Harper, J.M. and G.R. Jansen. Two off-line computer assisted nutrient standard menu planning techniques. USDA/FNA Contract 12–35–600–85, 1972.

Head, M.K. and R.J. Weeks. Conventional vs. formulated foods in school lunches. I. Comparison of student's food and nutrient intakes. **Journal of the American Dietetic Association**, 1977a, **71**, 116--123.

Head, M.K., R.J. Weeks and E. Gibbs. Major nutrients in the Type A lunch. I. Analysed and calculated values of meals served. **Journal of the American Dietetic Association**, 1973, **63**, 620--625.

Hoagland, G.W. The impact of federal child nutrition programs on the nutrition status of children. Paper presented before the Southern Economic Association Meeting, Washington, DC, November 1978.

Houser, H.B. and H.T. Bebb. Individual variations in Intake of Nutrients by day, month and season and relation to meal patterns: implications for dietary survey methodology. Presentation before Workshop on Evaluation of Methods of obtaining food consumption data, Washington, DC, 8–19 November 1978.

Huenemann, R.L. and D. Turner. Methods of dietary investigation. **Journal of the American Dietetic Association**, 1942, **18**, 562–568.

Hunt, I.F., L.S. Luke, N.J. Murphy, V.A. Clark and A.H. Coulson. Nutrient estimates from computerized questionnaires vs. 24-hour recall interviews. **Journal of the American Dietetic Association**, 1979, **74**, 656–659.

Ilg, F.L. The child's idea of what and how to eat. **Journal of the American Dietetic Association**, 1948, **24**, 658–660.

Jenkins, D.D. Plate waste – views on a complex issue. **Food and Nutrition**, 1976, **6**(5), 10–11.

Lowenberg, M.E. Food preferences of young children. **Journal of the American Dietetic Association**, 1948, **24**, 430–434.

Lund, L.A. and M.C. Burk. A Multidisciplinary Analysis of Children's Food Consumption Behavior. Agricultural Experimental Station, University of Minnesota Technical Bulletin 265, 1969.

Marr, J.W. Individual dietary surveys. Purposes and Methods. **World Review of Nutrition and Dietetics**, 1971, **13**, 105–164.

Odland, L.M., L. Page and L.P. Gould. Nutrient intakes and food habits of Montana students. **Journal of the American Dietetic Association**, 1955, **31**, 1134–1142.

Owens, L. and G. Sando. Observations of food acceptance during mental illness. **Journal of the American Dietetic Association**, 1954, **30**, 1110–1114.

Plate waste: Part I. **School Foodservice Journal**, 1976, **30** (Sept), 50–51.

Project Waste. **School Foodservice Journal**, 1976, **30** (Oct.), 80–81.

Rich, L. How MUNCH changed lunch at Oakham. **American Education**, 1978, **14**(8), 24–29.

Richardson, D.P. and M. Lawson. Nutritional value of midday meals of senior school children. **British Medical Journal**, 1972, **4**, 697–699.

Ruppenthal, B. and W. Hogue. Playground and plate waste. **School Foodservice Journal**, 1977, **31** (Apr.), 66.

Ruppenthal, B. Playgrounds and plate waste. **School Foodservice Journal**, 1978, **32** (July/Aug), 145–147.

Samuelson, G. An epidemiological study of child health and nutrition in a Northern Sweden County. II Methodological study of the recall technique. **Nutrition and Metabolism**, 1970, **12**(6), 321–340.

Schnakenberg, D.D. The Impact of Novel Military Feeding System on Dining Hall Attendance, Plate Waste, Food Selection and Nutrient Intake. Presentation at Food Acceptance Panel, National Conference, School Lunch Program Directors Meeting, El Paso, TX, 7 December 1976.

Skeel, A.B. Factors in food acceptance. **School Lunch Journal**, 1960, **14**, 32–33.

Steele, B.F., R.E. Franklin, V.L. Smudski and C.M. Young. Use of checked seven-day records in a dietary survey. **Journal of the American Dietetic Association**, 1951, **27**, 957–959.

Steele, B.F., V.L. Smudski, R.E. Franklin and C.M. Young. Comparison between three methods of assessing nutrient intake of children. **Massachusetts Agricultural Experimental Station Bulletin 469**, 1952, 59–62.

Thomas, R.V., M.M. Rutledge, E.F. Beach, E.Z. Moyer, M.C. Drummond, S. Miller, A.R. Robinson, O.N. Miller, M.N. Coryell and I.G. Macy. Nutritional status of children. XIII. Accuracy of calculated intakes of food components with respect to analytical values. **Journal of the American Dietetic Association**, 1950, **26**, 889–896.

Trulson, M.F. Assessment of dietary study methods. I. Comparison of methods for obtaining data for clinical work. **Journal of the American Dietetic Association**, 1954, **30**, 991–995.

Trulson, M.F. Assessment of dietary study methods. II. Variability of eating practices and determination of sample size and duration of dietary surveys. **Journal of the American Dietetic Association**, 1955, **31**, 797–802.

Trulson, M., D.M. Hegsted and F.J. Stare. New York State Nutrition Survey. I. A nutrition survey of public school children. **Journal of the American Dietetic Association**, 1949, **25**, 595-605.

USDA/FNS. Project SMILE/Suggested Methods for Improving Lunchroom Experience. Washington, DC. USDA, 1974.

USDA/FNS. The USDA study on high school participation in child nutrition programs. Washington, DC, USDA, no date.

Vance, T.F. Food selections of nursery school children. **Child Development**, 1932, **3**, 169–175.

Wair, B. and L.J. Roberts. Studies in the food requirements of adolescent girls. II. Daily variations in the energy intake of the individual. **Journal of the American Dietetic Association**. 1932, **8**, 323–331.

Warnick, K.P., S.V. Bring and E. Woods. Nutritional status of adolescent Idaho children. **Journal of the American Dietetic Association**, 1955, **31**, 486–490.

Watts, M. Fighting and winning the plate waste battle. **School Foodservice Journal**, 1976, **30**, 71–76.

Widdowson, E.M. A study of individual children's diets. Medical Research Council Special Report Service #257, H.M. Stationery Office, London, 1947.

Young, C.M., F.W. Chalmers, H.N. Church, M.M. Clayton, R.E. Tucker, A.W. Werts and W.D. Foster. A comparison of dietary study methods. I. Dietary history vs. seven-day recall. **Journal of the American Dietetic Association**, 1952, **28**, 124–127.

Young, C.M., R.E. Franklin, W.D. Foster and B.F. Steele. Weekly variation in nutrient intake of young adults. **Journal of the American Dietetic Association**, 1953, **29**, 459–464.

Young, C.M., G.C. Hagan, R.E. Tucker and W.D. Foster. A comparison of dietary study methods. II. Dietary history vs. seven-day record vs. 24-hr. recall. **Journal of the American Dietetic Association**, 1952, **28**, 218–221.

Young, C.M. and H.L. Pilcher. Nutritional status survey, Groton Township, NY. II. Nutrient usage of families and individuals. **Journal of the American Dietetic Association, 1950, 26,** 776–781.

Young, C.M., V.L. Smudski, B.F. Steele. *Fall and Spring diets of school children in NY State.* **Journal of the American Dietetic Association,** 1951, **27**, 289–292.

Young, C.M. and M.F. Trulson. Methodology for dietary studies in epidemiological surveys. II. Strengths and weaknesses of existing methods. **American Journal of Public Health, 1960, 50**(6), 803–814.

APPENDIX

Table A–1. **Aggregate Selective Plate Waste for 244 Students at School 1**

Food Item	Total Grams Waste
Spaghetti and Meat Sauce	5614
French Bread with Margarine	1176
Tossed Salad with Dressing	3044
Sandwich 1, White Bread	241
Sliced Turkey	62
Peanut Butter and Marshmallow Fluff Sandwich	289
Peanut Butter and Jelly Sandwich	222
Submarine Sandwich, Roll	898
Bologna	301
Salami	435
Cheese	287
Lettuce from Sandwich 1 or Sub Sandwich	199
Tomato from Sandwich 1 or Sub Sandwich	269
Pickle	241
Potato Chips	155
Pudding, Chocolate	990
Whipped Topping	161
Fresh Apple	2740
Fresh Banana	580
Fruit Punch	515
Milk, Whole and Skim combined	29162

Table A–2. **Aggregate Selective Plate Waste for 310 Students at School 2**

Food Item	Total Grams Waste
Breaded Fish and Cheese Cakes	942
Sandwich Bun for Fish Cakes	1294
Tartar Sauce	1317
Cole Slaw	4575
Sandwich 1, White Bread	162
Sliced Ham	375
Peanut Butter and Marshmallow Fluff Sandwich	162
Peanut Butter and Jelly Sandwich	148
Submarine Sandwich, Roll	1223
Bologna	375
Salami	77
Chopped Lettuce and Tomato	48
Cheese from sandwich 1 or Sub Sandwich	899
Pickles	488
Potato Chips	495
Cookies	1918
Fruit Punch	4983
Milk, Whole White	20083
Milk, Skim	220

Table A–3. Aggregate Selective Plate Waste for 149 Students at School 3

Food Item	Total Grams Waste
Hamburger Patty	1398
Sesame Seed Bun	1859
Canned, Sliced Peaches	5895
Apple Juice	1391
Milk, Whole White	810
Milk, Chocolate	6002

Table A–4. Aggregate Selective Plate Waste for 539 Students at School 4

Food Item	Total Grams Waste
Cheese Pizza	2884
Mixed Frozen Vegetables	15873
Canned Pear Halves	1419
Spice Cake with Orange Frosting	1797
Milk, Whole White	2180
Milk, Chocolate	10538

Table A–5. Aggregate Selective Plate Waste for 263 Students at School 5

Food Item	Total Grams Waste
American Chop Suey	6024
Canned Green Beans in Butter Sauce	1773
Hamburger, Grilled with or without Cheese	477
Cheese, from Cheeseburger, Sub, and Salad Bar	29
Hamburger Roll, from Sub also	1342
Hot Dog	42
Hot Dog Roll	128
Submarine Sandwich Cold Cuts	300
Pickles	38
French Fries	1051
Fresh Apple*	419
Fresh Orange*	383
Cake, Chocolate with Nuts	349
Cake, White with Chocolate Frosting	956
Salad Bar, Mixed Tossed Salad**	1815
White Bread with Margarine	557
Ketchup for French Fries and Burgers	163
Fruit Cocktail	112
Potato Salad	29
Milk, Whole White	2964
Milk, Chocolate	2784
Milk, Coffee-Flavored	717

*Weighed with peels and seeds

**Included lettuce, tomato, cucumber, onion, bacon bits, dressing, and cottage cheese